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DROP OF CHINESE CABBAGE AND OUR COMMON CABBAGE CAUSED BY SCLEROTINIA SCLEROTIORUM (LIB.) MASSEE (SCLEROTINIA LIBERTIANA FCKL.)

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WITH THREE FIGURES IN THE TEXT AND PLATES III TO IV

INTRODUCTION

In the late summer and fall of 1923 and 1924, sclerotia were observed on rotting Chinese cabbage and common cabbage growing in the vegetable gardens of the Massachusetts Agricultural College. The problems which arose while these sclerotia were under observation follow:

1. Are these sclerotia of a pathogenic organism?
2. Is a Botrytis stage associated with the sclerotia?
3. Will cultures of mycelium and ascocarps from these sclerotia show an etiology similar to *Sclerotinia libertiana* Fekl.?
4. What is the specific Latin binomial for the fungus on each host?

THE DISEASE

A description in the literature of this sclerotial disease on Chinese cabbage has not come to the writer's attention. Harter and Jones (7: 24)[1] described the disease on common cabbage as drop (watery soft-rot). In 1924, it was reported from New York and Louisiana as watery soft-rot (9: 197), while Gardner (5: 16) observed a damping-off of cabbage seedlings and a collar-rot of the stem. However, drop of Chinese cabbage seems to be the most suitable common name for this disease since the symptoms are identical with those on other plants infected with the same organism. The following varieties of Chinese cabbage were diseased and under observation: Petsai or Pekin (*Brassica Pe-Tsai* Bailey),[2] Chokurei, Paoting or Wong Bok, Kinshiu and Chosen.[3]

While there were few plants, twenty-four in each varietal row, the loss due to the disease exceeded fifty per cent as the leaves and "leaf-stalks" were generally reduced to rotting masses. Only three of the plants fruited.

[1] Numbers in parenthesis refer to the reference and page in the literature cited.

[2] Classification of all genera and species of cabbage is that reported by L. H. Bailey, Manual of Cultivated Plants. 1924.

[3] All varietal names for Chinese cabbage and cultivated cabbage are those printed in Simon and Son's 1923 catalog from whom the seeds were ordered.

The disease made its first appearance during the month of September when the lower leaves which were in contact with the soil began to turn brown, "dropped" and finally assumed a shapeless mass. Further examination showed that the petioles and blades were rotted and other leaves attached to the stem directly above "flagged" and appeared water-soaked and sometimes slimy. Mycelium on the surface of these leaves had not made its appearance to the unaided eye and, at first, the disease was thought to be soft rot caused by *Bacillus carotovorus* L. R. Jones. Later, however, white floccose mycelium and sclerotia developed under and between portions of the old rotting leaves (Figs. 1 and 2; Plate IV, no. 4).

FIG. 1. An infected plant of Chinese cabbage. At the base are diseased leaves which have dried. A—A leaf showing "drop." B—White floccose mycelium.

The symptoms in the stems and floral stalks varied. Their interiors were either reduced to a soft rotting mass or turned brown, dried and easily crumbled. Many times the connection between the root and stem was broken at a point just below the surface of the soil where injury was most apparent. Within the dry, hollow, diseased flower-stalks and stems were large patches of mycelium and numerous sclerotia.

Both young and matured plants became infected. In young plants the fungus appeared to advance from the soil to the leaf axils and formed a rapidly spreading water-soaked area along "winged" portions of the blades which are attached to the margins of the petioles. In about 24 hours the infected leaves "dropped" and others above these were likewise attacked. In two cases the stems were entirely rotted and the plant "dropped" in 48 hours.

FIG. 2. Photograph of the plant shown in figure 1 taken one month later. The plant has entirely succumbed to the disease. A–B—Large sclerotia.

The symptoms of the disease on cultivated Danish ballhead cabbage (*Brassica oleracea* var. *capitata* L.) have been described by Harter and Jones and, in general, they were similar to those here described for Chinese cabbage. Numerous sclerotia generally appeared on the surface of diseased cabbage heads, but they seldom appeared on the leaf blades and axils within the cabbage head. About ten per cent of the cabbage heads were reduced to a soft rotting mass, while five per cent of the remaining plants were infected. Some diseased cabbage heads turned brown and dried, but retained their shapes while still attached to the roots. Isolations of *B. carotovorus* from the soft-rotting cabbage heads would indicate that this bacil-

lus was acting in conjunction with the Sclerotinia, and the two organisms caused watery soft-rot, while the Sclerotinia alone formed a drop which normally ended in a drying of the cabbage heads without a total disorganization of the plant body (Fig. 3).

THE CAUSAL ORGANISM

Sclerotia: After a heavy frost on November 1, 1923, abundant white tufts of mycelium appeared on the water-soaked areas of leaves, stems, and leaf axils of Chinese cabbage. These tufts varied in size from a millimeter to several centimeters in length, and about one week later they had transformed into white sclerotial bodies. These bodies turned from a cottony-white to a gray and finally to a black color which signified maturity. Ma-

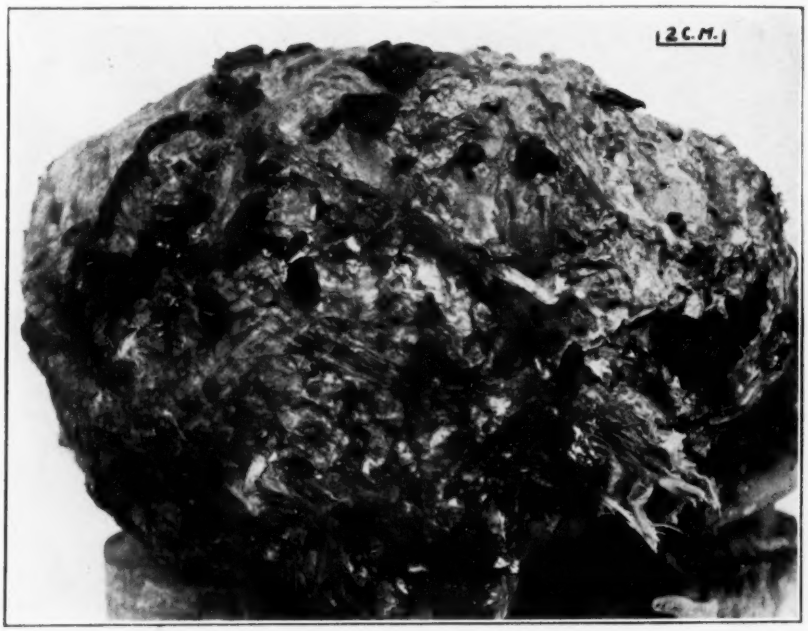

FIG. 3. Sclerotia on a cabbage head.

tured sclerotia easily separated from the underlying mycelium and fell to the ground, especially when the host materials were disturbed. The sclerotia were irregular in outline and the lower surface lying next to the mycelium and host was concave, while the upper free surface was convex. Under a hand magnifier the surfaces showed many small papillae or mounds, often giving them a botryoidal appearance (Plate III, nos. 4 and 5). Stained sections, when highly magnified, showed an outer rind of from two to five

rows of roundish cells with thick angular walls of an unstained burnt-umber color. The interior was composed of a gelatinous structure of interwoven hyphae, the medulla. Within these hyphae were numerous small, globose bodies which readily stained with gentian violet. The primordia were scattered and near the periphery of the medulla.

Sclerotia varied in size from minute globose or oblong bodies less than 1 mm. to those 3 cms. in length, mostly 5 to 7 mms. (table 1). Under warm, dry conditions, the maximum period of viability was ten months. These sclerotia were collected November 10, 1923, and placed in an open glass jar which was stored in the laboratory. Three of the fifty sclerotia remained viable, bearing ascocarps when placed under the proper conditions. Other sclerotia collected on the same date and stored under the same conditions were placed in moist soil on March 10 and over eighty per cent produced abundant apothecia, thus showing viability after four months storage. Sclerotia stored in damp soil either formed ascocarps early in the following spring or entirely disappeared by the following autumn. This would substantiate the belief that under natural conditions sclerotia do not remain viable near the surface of the soil longer than one year. However, this does not account for those which might have been buried deep in the soil by plowing and returned to the surface by further tillage.

Ascocarps: In November, 1923, abundant matured sclerotia were collected from Chinese cabbage and cultivated cabbage and stored in open glass jars as previously described. In February, 1924, sclerotia from each stored sample were sparsely covered with saturated greenhouse soil placed one inch deep in eight-inch glass moist chambers. These jars were covered, set on a laboratory table near a window in a temperature averaging 20° C., and the soil was kept in a wet condition. On April 15, abundant ascocarps had developed from most of the sclerotia (Plate IV, nos. 1, 2, 3, and 5; Plate III, no. 2). At this time other stored sclerotia were cultured under similar conditions and bore matured ascocarps on June 7. Ascocarps continued to develop in the jars until the following October. Measurements of ascocarps and their parts were made from materials under the following conditions: fresh, preserved in 70 per cent alcohol, and stained sections.

Table 1 shows that the average height of ascocarps was 15 mm. However, these ascocarps were cultured from sclerotia planted just beneath the surface of the soil. No experiments were performed to determine the relation between the height of ascocarps and the depth of sclerotia in the soil.

Near the sclerotia, the stipes were a deep brown which shaded to a chestnut color and finally blended with the light-gray color of the upper stipe and apothecial cups at a point averaging 5 mm. from the sclerotia. As many as 38 ascocarps formed from a single sclerotium.

TABLE 1.—*Measurements of sclerotia, ascocarps, ascospores, asci and paraphyses of Sclerotinia sp. on Chinese cabbage compared with those of Sclerotinia libertiana Fuckel as reported by Saccardo*

	Sclerotia (mms.)	Ascocarps (mms.)	Ascospores (μ)	Asci (μ)	Paraphyses (μ)
Author	(1) Minute–30	0.3–1 x 10–18	4–6 x 9–11	5– 9 x 100–125	1.5–2.5 x 110–118
	(2) 5–7	0.7 x 15	4.5 x 10.8	9 x 113	2 x 113
Saccardo	To 30	.....	4–6.5 x 8–13	8–10 x 130–135	.....

(1) Limits for 50 specimens measured.
(2) Averages for 70 per cent of the specimens measured.

Ascospores from fresh materials averaged 4.5 x 10.8 μ; from materials preserved in 70 per cent alcohol, 4.5 x 9 μ, and in stained sections on prepared slides, 3.5 x 7.2 μ (Plate III, nos. 1 and 3).

The widths of asci varied from 5 to 9 μ; lengths, 100 to 125 μ; average size, 9 x 113 μ. Table 1 shows that these measurements for the widths compare favorably, but the lengths are somewhat less than those reported by Saccardo for *S. libertiana*. The ascospores had not been discharged from most of the asci measured. However, the characteristic "blue tips" were evident. The clavate paraphyses averaged 2 x 113 μ (Plate III, no. 1).

Fresh ascocarps from sclerotia on common cabbage were sectioned and their parts measured. These measurements compared favorably with those reported for Chinese cabbage in table 1, so they were omitted. Thus the measurements of the ascocarps and their parts, except the length of the asci, compared favorably with those reported by Saccardo for *S. libertiana*.

Mycelium was isolated from diseased plants of Chinese cabbage, head lettuce (*Lactuca scariola* var. *capitata* L.), and common cabbage bearing sclerotia. The fungus in each isolation was transferred to potato agar slants and sterile bean pods. With these cultures, inoculations within the three named host species and reciprocal inoculations were made by placing mycelium on the stems and leaves in contact with the soil, in the leaf axils, and on aerial portions, as the upper leaf blades. Both young and old plants of Chinese cabbage, lettuce, and common cabbage were inoculated and the work was performed under greenhouse conditions.

The results showed infections when both reciprocal inoculations and inoculations within the host species were made. Thus, this Sclerotinia on these three hosts possesses one species and no physiological races.

As the leaves bore "target spots," attempts were made to isolate a Botrytis and determine if it was associated with the life cycle of *S. liber-*

tiana. Species belonging to the following genera of fungi were isolated: *Botrytis, Alternaria, Fusarium,* and *Penicillium.* Each fungus was grown in pure culture from single spore isolations, but several inoculations of Chinese cabbage with each culture failed to produce infections. Neither a Botrytis stage nor microconidia were observed in any of the cultures from the sclerotia or the mycelium.

TAXONOMY

According to a fixed custom, early German writers (De Bary, Wakker, Kissling) treated this fungus as *Peziza sclerotiorum* Libert. However, Miss Wakefield (12: 126) has shown that Massee formed the new genus Sclerotinia and the specific Latin binominal is *Sclerotinia sclerotiorum* (Lib.) Massee instead of *Sclerotinia libertiana* Fuckel which is generally adopted by our mycologists.

Kissling (8: 229) states that Eidam described black bodies on cabbage heads and classified them as *Sclerotinia compactum* DC. Eidam claimed that a Botrytis stage was associated with this fungus. Harter and Jones described drop of cabbage and attributed the cause to *S. libertiana* Fuckel. The writer found no Botrytis stage definitely associated with the life-cycle of this fungus on Chinese cabbage or on common cabbage. The morphology of the organism is, in general, identical with descriptions of *Sclerotinia sclerotiorum* (Lib.) Massee.

TERATOLOGICAL FORMS

De Bary (2: 51) observed "exogenous branches" of *Peziza sclerotiorum* near the ground and believed them "purely adventitious, artificially excited or monstrous." Worsdell (14) has discussed teratological forms of various fungi and grouped them in seven classes, three of which are: dichotomy, fasciation, and proliferation.

Teratological forms of ascocarps were observed in cultures of sclerotia which had been collected from Chinese cabbage (Plate IV, nos. 3 and 5). Unbranched cylindrical bodies (ascocarps) grew from sclerotia sparsely covered with soil, branched dichotomously at the surface of the soil, and each branch in its early growth appeared to develop normally into an ascocarp averaging 0.5 cm. in diameter at the base, 1 mm. in diameter near the apex, and 1 cm. in height. Later, the apex (apothecial cup) of this primary ascocarp turned a gray-brown color and increased in diameter from 1 to 4 mm. At first it was clavate and then cup-shaped with involute, crenate margins. Between the crenae, secondary ascocarps developed and these varied from 1 to 3 mm. in length and about 0.5 in diameter with as many as fifty individuals from one cup. Tertiary ascocarps developed on the apex of secondary ascocarps and were from 2 to 5 mm. in height, less than 1 mm.

in diameter, and 2 to 5 in number. However, there were variations in branching, number, size, and shape of the primary, secondary, and tertiary ascocarps. The above description is for the majority of the cases examined and may be classed with those due to proliferation.

Several specimens of another type came under observation. Each had an apparently normal apothecial cup, bearing on its upper surface two rows of secondary ascocarps arranged in concentric circles (Plate IV, no. 3).

Free-hand sections of apparently matured primary, secondary, and tertiary ascocarps showed that ascospores were seldom formed. However, one especially well developed secondary ascocarp without tertiaries possessed ascospores. The ends of the hyphae in the apothecial cups were often well developed, clavate, and similar to paraphyses.

Any cause which might be responsible for the formation of these teratological forms would only be speculation since experimental data are not at hand. The hyphae which form the ascocarp develop from the primordia within the sclerotia and are of two types: those which originate in its periphery, the peripheral hyphae, and those which originate above the center, the central hyphae. At first, these two types of hyphae are distinguishable, for the cells of the peripheral hyphae are the longer, but as the ascocarp matures their identity is lost. It is generally believed that the ascogenous hyphae come from the primordia and are the central hyphae. Thus any interruption in the development of the central hyphae would suspend the formation of asci for the time being and perhaps definitely. It would seem that this is what took place; the peripheral hyphae had precedence over the central hyphae which had been delayed in their development for some undetermined cause. However, there yet remains to be explained why the apothecial cup of the primary ascocarp assumed the potentialities of a sclerotium; that is, formed new primordia which would seem necessary for the formation of secondary ascocarps.

Worsdell (14) states that botanists believe abnormal structures are due to one of the following: pure accident; direct action of environment; phylogenetic or hereditary causation.

In this case it would not seem to be due to pure accident for the majority of fifty ascocarps from several sclerotia bore teratological forms.

Environment could not have been the sole factor for producing these forms because normal ascocarps developed in the same cultures simultaneously with teratological forms and in one case apparently from the same sclerotium.

Shall we accept the theory that phylogenetically the ancestors of this Sclerotinia bore apothecia or perhaps perithecia on flattened receptacles not entirely unlike the stromata of *Claviceps purpurea* Tul.?

DISCUSSION

De Bary stated that the ascospores of this fungus germinated at once and formed saprophytic mycelium which remained in the soil during the spring and summer. Parasitic mycelium was formed later in autumn. Poole (10) observed that the infection of celery by this organism under greenhouse conditions occurs almost simultaneously with the formation of apothecia or the development and liberation of ascospores. However, it seems that more observations and experimentations with this fungus should be made before an accurate life history on the different hosts can be stated. However, there is a possibility that the life history of this organism varies according to the host parasitized.

Observations showed that the ascospores from apothecia of this fungus germinated at once, and from two inoculations it was concluded that their germ-tubes would not infect. The fact that the disease appeared late in the autumn instead of early in the spring when apothecia were formed, would also substantiate the fact that the germ-tubes from ascospores do not infect at once. However, buried sclerotia which deep cultivation might have brought to the surface of the soil may have continued to form ascocarps until August. Then the formation of apothecia would have occurred through the summer. Environmental conditions of the hosts might have favored infection, but these conditions are unknown to the writer. Young plants as well as old ones were artificially infected in the greenhouse, and it does not seem probable under the existing field conditions that the old plants were more susceptible than the young.

It was interesting to note the short distances which the mycelium grew over the surface of the soil from the centers of infection; 5 cm. was the longest distance observed. However, the fungus did progress from one plant to another when healthy plants came in contact with the diseased. Thus close planting should be avoided as it aids the dissemination of the organism.

The ability of sclerotia to form mycelium in the spring after passing the dormancy of winter still remains unsolved. Is all the mycelium in all sclerotia destined to form apothecia? A sufficient number of sclerotia should be tested to give definite data, but the writer has found it difficult to culture half a matured sclerotium for viable mycelium and the other half for the formation of apothecia. A "balance" in the sclerotium has been upset and parasitic mycelium might become vegetative under these conditions or *vice versa*. Thus, if the complete life history of this organism should be given at this time, a part of it would be nothing short of speculation.

SUMMARY

1. Sclerotia were collected from diseased Chinese cabbage and common cabbage.

2. Mycelium and apothecia were cultured from sclerotia.

3. Measurements of mycelium, sclerotia, apothecia, asci, ascospores, and paraphyses showed the fungus in general to be identical with *Sclerotinia libertiana* Fuckel, as described by Saccardo.

4. Infections were obtained by inoculating Chinese cabbage, head lettuce, and common cabbage with pure cultures derived by isolating mycelium of Sclerotinia from each host.

5. No physiological races of the fungus on these three hosts were observed.

6. Germ-tubes from ascospores failed to infect the living host tissues.

7. The fungus did not progress on the surface of the soil more than 5 cm. from the center of infection.

8. The disease progressed from infected plants to healthy plants with which they were in contact.

9. The complete life cycle of the fungus is unknown, but observations point toward the ascospores forming saprophytic mycelium, and this in turn forming parasitic mycelium later in the season.

10. No Botrytis stage was found to be associated with this Sclerotinia. The specific Latin binominal for this fungus on Chinese cabbage and common cabbage is *Sclerotinia sclerotiorum* (Lib.) Massee.

11. Teratological forms were observed in which the margins of apothecial cups formed secondary ascocarps by proliferation. Tertiary ascocarps were formed on secondaries.

12. In general, these teratological forms did not bear ascospores.

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PLATE III

Camera lucida drawings of sclerotia, ascocarp, ascus, ascospores, and paraphysis of *Sclerotinia sclerotiorum* (Lib.) Massee from Chinese cabbage.

Number 1. A. Ascus containing eight ascospores.
B. Paraphysis.

Number 2. Outline drawing of an ascocarp from a prepared slide.
A. Hymenium.
B. Sub-hymenium.
C. Stipe.
D. Canal.
E. Point of attachment to the sclerotium.

Number 3. Ascospores stained with Fleming's safranin, gentian violet, orange G stain.

Number 4. Different sizes and shapes of sclerotia.
A. The upper surface showing white mycelium.
B. A black, matured sclerotium.

Number 5. Irregular upper surface (O) of a sclerotium shown in 4B. × 10.

PLATE IV

Symptoms, sclerotia, ascocarps and tetratological forms of *Sclerotinia sclerotiorum* (Lib.) Massee on Chinese cabbage and common cabbage.

Number 1. Ascocarps of one sclerotium from common cabbage.

Number 2. Ascocarps on a sclerotium from Chinese cabbage.

Number 3. Teratological forms of ascocarps from Chinese cabbage.
A. The secondary ascocarps arranged in two concentric circles.
B. Tertiary ascocarps forming on the apex of secondary ascocarps.

Number 4. Portion of a Chinese cabbage leaf.
A. Sclerotium.
B. Mycelium.

Number 5. Secondary ascocarps forming on the margins of primary apothecial cups. The sclerotia were collected from Chinese cabbage.

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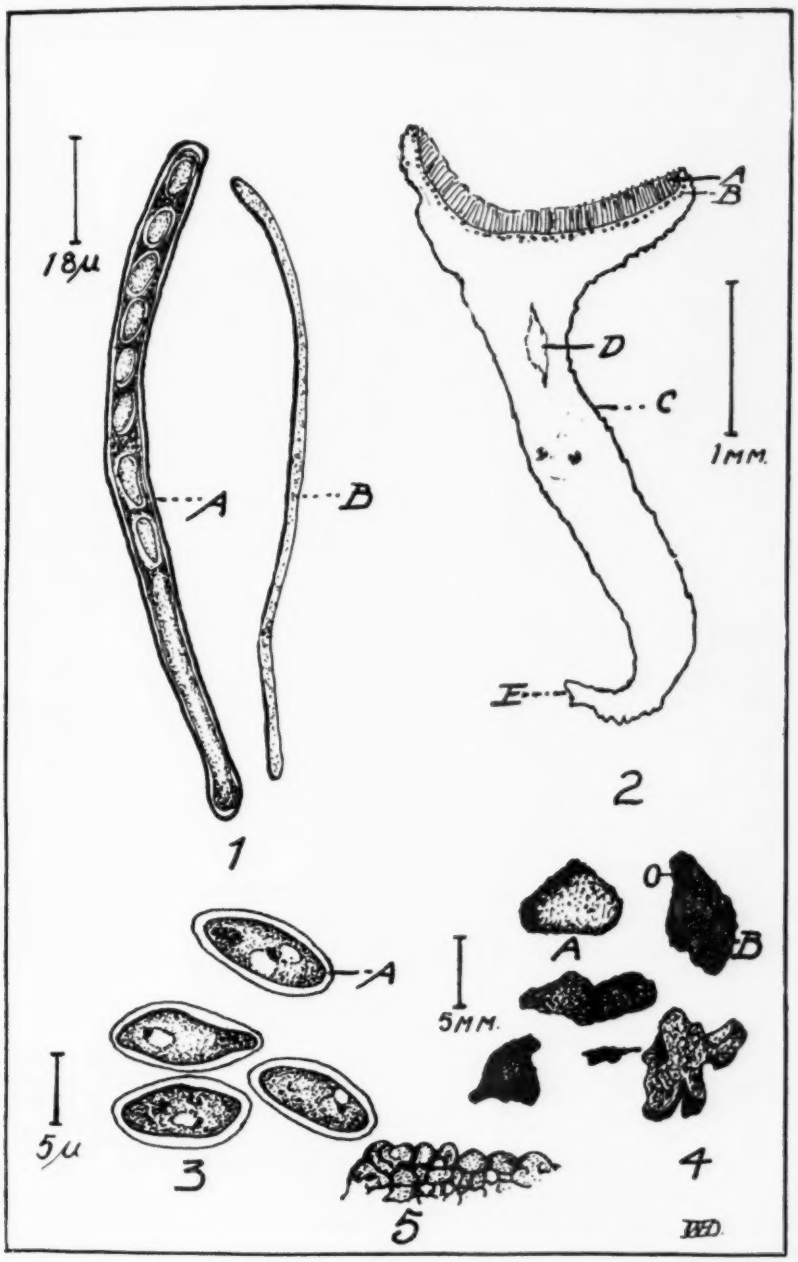
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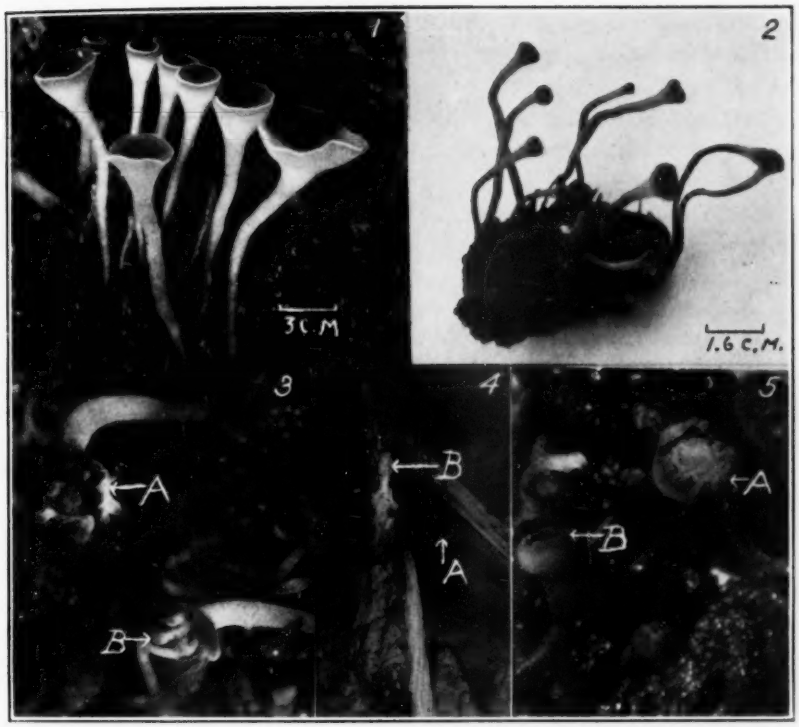
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ANTHRACNOSE OF EUROPEAN PRIVET

A. J. Mix

With Three Figures in the Text

Anthracnose of European privet, *Ligustrum vulgare* Linn. (more commonly called English privet), was described by Atkinson (1) in 1892. The material which he studied had been received from Penn Yan, New York. He stated that on some of the twigs from twelve to eighteen inches of the terminal growth was dead, and a distinct line was evident between the dead bark and the healthy tissue below. Other twigs with apparently healthy portions bore cankers at a point twelve to eighteen inches from the end. In some cases the canker girdled the twig, causing death of the terminal portion. Acervuli of the causal fungus were evident in the diseased bark of affected twigs.

Atkinson studied and described the fungus. He mentioned its probable relationship with *Gloeosporium fructigenum*, as the fungus causing the bitter rot of apples was then known, but found points of difference which made him decide to call it a new species. The privet fungus thus became known as *Gloeosporium cingulatum* Atkinson. Subsequently Miss Stoneman (5) described the perithecial stage of this fungus, using Atkinson's original cultures and cultures which she had isolated from material received from Manhattan, Kansas. She named the fungus *Gnomoniopsis cingulata*. Incidentally, Miss Stoneman describes a leaf spot bearing acervuli as occurring in some of the privet material received from Kansas. The writer has never observed such a leaf spot.

Von Schrenk and Spaulding (4) found it necessary, on account of priority, to rename the genus *Glomerella*, so that the accepted name of the privet fungus is now *Glomerella cingulata* (Atk.) Spaulding and von Schrenk.

Shear and Miss Wood (3) have shown that the asexual or Gloeosporium stage of *Glomerella cingulata* may occur on a wide range of host plants. It would appear from their work that the fungus on privet is identical with that causing the well known bitter-rot disease of apples.

Although the fungus in question has been the subject of considerable study, there seems to be no later account of this privet disease than that given by Atkinson. This might indicate that it has not caused serious damage over any considerable territory.

OCCURRENCE OF THE DISEASE

The writer's attention was called to this disease in the summer of 1921 by Mr. S. Herbert Hare, of the firm of Hare and Hare, Landscape Archi-

tects of Kansas City, Missouri. During the seasons of 1921 to 1924 the disease has caused serious damage to hedges of European privet in the residence section of Kansas City known as the Country Club District. In well established hedges, five years or more old, many plants blighted to the ground, so that part or all of the hedge had to be removed. In some cases where part of the hedge was removed and replanted the replants blighted. The disease is especially serious, as the death of portions of a hedge may necessitate the removal and replacement of the entire hedge, a matter of several years. The destructive effect of the disease on a privet hedge is shown in figure 1.

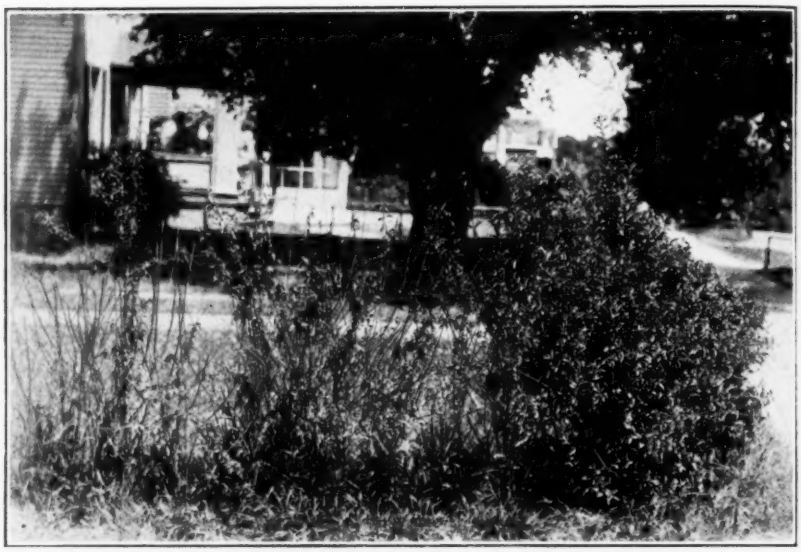

FIG. 1. A hedge of European privet dying from the effects of the anthracnose.

Subsequent to finding the disease in Kansas City, the writer located several diseased hedges in Lawrence, Kansas. These hedges have since died. In 1924 specimens of the disease were received from Bartlesville, Oklahoma. It is not known in what other localities the disease may occur, as no search has been made.

The anthracnose has been found only on European privet, and on a privet called Golden Russian by Mr. Hare. A hedge of this privet, planted by Mr. Hare in the spring of 1921, died that same season. Hedges of other privets, Amur, Ibota, Regel, and California, are common in the localities mentioned, but no case of the disease has ever been found in any of them.

FIG. 2. A plant of European privet dying as the result of artificial inoculation with *Glomerella cingulata*. The notch in the stem below the ground line indicates the place of inoculation. The branch to the right has remained healthy.

DESCRIPTION OF THE DISEASE

Symptoms of the disease, as observed in Lawrence and Kansas City, are somewhat different from those described by Atkinson. The twig blight and twig canker have been frequently found and these manifestations of the disease accord with his descriptions. More commonly the whole plant is affected. Such a plant shows dead dry leaves which cling persistently and turn first pale green and later brown. The bark and wood of the upper portions of the plant remain bright colored until after the death of the leaves, later appearing brown and dead, but free from fungous invasion. The appearance of a dying plant is shown in figure 2, which, however, represents a plant which had been artificially inoculated.

Examination of the basal portion of a diseased plant reveals one or more cankers on the main stem just above the ground line or even below it. These cankers are at first long-oval in outline but eventually they enlarge and coalesce until the stem is girdled. The diseased bark is brown and frequently shows acervuli of the fungus. A dead stub is usually evident in the canker, indicating that the fungus entered by way of a blighted basal shoot. The wood beneath a canker is discolored brown or grayish black. This discoloration may extend only a little way into the wood or may involve the whole interior of the stem, depending on the age of the canker. Typical cankers and the discoloration of the subjacent wood are shown in figure 3.

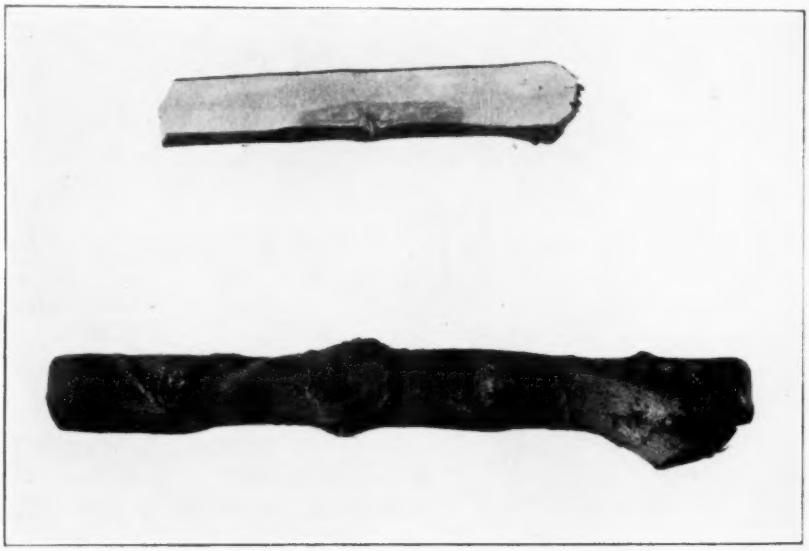

FIG. 3. Stem cankers caused by the anthracnose fungus. Dead stubs indicate the place of entrance of the organism. The split stem shows the typical discoloration of the wood beneath a canker.

Microscopic examination of sections of cankers shows that all the tissues of the bark are brown and dead. Mycelium of the fungus may be observed between or within the cells of all tissues except the bast fibers. In the wood the mycelium is never abundant, but hyphae may be seen here and there within the cells of the xylem and medullary rays, and are most readily seen crossing or extending up and down the tracheal tubes. There is no disintegration of the tissues of the wood until late stages of the disease when the wood has apparently become invaded by other fungi.

Although the mycelium is common in the tracheal tubes, there is no evidence that its presence there is directly responsible for the death of the plant, as is the case with wilt-diseases of other plants. Apparently the plant dies only after the bark and wood of a portion of the stem have been killed. This may not occur the same season as infection, but often the second or third season thereafter. Sometimes one or more branches die the first year, and the rest of the plant the year following.

The roots are apparently not infected, at least so long as the plant is alive. Isolations from old decaying roots of dead plants have yielded a variety of organisms but not the anthracnose fungus.

These observations show that this privet disease is more destructive than is indicated by Atkinson's description. As he dealt only with material which had been sent to him from a distance, it is possible that he was unfamiliar with the more severe manifestations of the disease. Again it is possible that it is more destructive in the middle west than in the east. As observed here the disease would be aptly characterized by the term privet blight, but it seems unwise to substitute this name for the well established, though less appropriate one of privet anthracnose.

The disease usually becomes evident in late June or early July, and the number of dead or dying plants gradually increases throughout the season. The incidence of the disease corresponds closely to the coming of hot weather, and seasons in which the disease has been especially destructive have been rather hot and rainy.

ISOLATIONS

Isolations from the basal portions of diseased plants were made at different times during 1921, 1922, and 1923. Fragments of wood were removed, under aseptic conditions, from the interior of diseased stems and placed in tubes of potato dextrose agar. Isolations were made from twenty-two plants, two of which were Golden Russian privet, the remainder were European. The results may be summarized as follows: total number of tubes, 151; *Glomerella cingulata*, 117; *Verticillium* sp., 5; miscellaneous undetermined fungi, 16; blank, 13. One set of poured-plate isolations which was made from acervuli on diseased twigs yielded pure cultures of *Glomerella cingulata*.

BEHAVIOR OF THE FUNGUS IN CULTURE

Single-spore strains of the fungus were not employed for the cultural studies, but separate cultures, each arising from a separate isolation, were used. No extensive study of cultural relations was attempted, inasmuch as the important facts regarding the behavior of *Glomerella cingulata* in culture are already well known.

The fungus was grown on a number of common media, including potato dextrose agar, corn meal agar, oat agar, corn meal, and rice. Some variation in character and amount of growth on different media was observed, but none worth reporting. Corn meal agar proved to be the best medium for the formation of perithecia.

On potato dextrose agar the fungus grows rapidly, producing an abundant aerial mycelium. Considerable variation was noticed between different cultures as to the color of this mycelium, it varying from deep gray to grayish white or nearly pure white. On corn meal agar and on all agars containing dextrose, certain cultures produce a red pigment which diffuses into the agar. In other cultures this pigment is lacking.

In most cultures black stromata appear in about a week. These are scattered without order over the surface of the agar. The characteristic oblong conidia of the fungus are borne in these stromata or on the tips of long aerial hyphae. In some cultures the formation of stromata and conidia is almost entirely suppressed; such cultures, when older, produce perithecia abundantly.

Immature perithecia have been found in cultures two weeks old, and mature ascospores in cultures six weeks old. The perithecia and ascospores agree with the descriptions given for this fungus by Miss Stoneman (5) and others.

It has been mentioned that corn meal agar is a favorable medium for the production of perithecia, but, as Shear and Miss Wood (3) have pointed out, the ability to form perithecia seems to be an inherent quality of a particular strain of the fungus rather than something induced by the culture medium. Of twenty-two cultures, each representing a separate isolation of the fungus grown on corn meal agar, fifteen produced perithecia. In seven of these cultures mature ascospores formed before the end of twelve weeks, and in seven cultures no perithecia were found.

INOCULATIONS

The objects of the inoculation experiments were: (1) to establish the pathogenicity of the fungus for European privet; (2) to see if the observed immunity of the other privets held true; (3) to determine if spores of the fungus could enter uninjured twigs; (4) to study possible relations between *Glomerella cingulata* from privet and the same fungus from apple.

For purposes of inoculation a number of young plants (apparently two years old) were obtained in March, 1922, and divided into two lots. One lot was planted in the greenhouse, the other out of doors. The following privets were represented: European, Amur, Ibota, Regel, and California.

Inoculations were made on the indoor plants on July 3. The dirt was scraped away from the base of a plant and an incision made in the stem with a sterilized scalpel. Mycelium and agar from a seven-day culture were placed in the incision and the dirt replaced. Similar incisions were made in the stems of the plants used as controls, but no mycelium was inserted. Control plants were in a part of the bed distant from the inoculated plants. Of the four inoculated plants of European privet, one was entirely dead at the end of two months and another was dying. A photograph of this dying plant is reproduced in figure 2. A third plant was found diseased at the end of three months and this and the fourth plant were entirely dead in six months from the time of inoculation. The one European plant used as a control remained healthy. The appearance of the diseased plants was typical of the disease as observed under natural conditions, and the usual discoloration of the wood was found around the point of inoculation. The fungus was reisolated from the discolored stems of each of these diseased plants.

Inoculated plants of the other privets: four plants each of Amur and California, and three each of Ibota and Regel remained healthy, and at the end of six months the incisions in their stems had healed. The same was true of the control plants: two plants of Regel and one each of the other privets.

Four plants of European privet growing out of doors were inoculated in a similar manner on July 19. Two months later a main branch of one plant was dead to its base, but the rest of the plant appeared healthy. The fungus was recovered from the lower part of the diseased branch. This plant died early the following year, showing typical symptoms of anthracnose. Of the remaining plants, one was observed to be diseased at the base in July, 1923. This and a third plant died late that summer. The fourth plant appeared healthy until 1924 when it also died. One plant used as a control remained healthy for two years, dying in 1924 as the result of later inoculation.

Inoculations were also made on four plants each of Ibota and Regel privets, on three plants of California, and two of Amur. One plant of each was used as a control. All inoculated and control plants remained healthy.

A number of inoculations were made in twigs of privet plants growing out of doors. A slit was made in the bark by means of a sterilized scalpel

and inoculum inserted. The wounds were left unprotected. Similar incisions, to serve as controls, were made in other twigs, but no inoculum was inserted. The results of these inoculations are summarized in table 1. The infections recorded in this table consisted in a few cases of small cankers around the incisions; but, in most cases, a die-back of the twig resulted which extended considerably below the point of inoculation. Acervuli of the fungus were evident on many of the diseased twigs. The two infections of control twigs noted in the table were small cankers formed around the incisions. Evidently these resulted from natural inoculation.

The inoculated twigs were too small for easy removal of diseased wood under aseptic conditions. Reisolations were therefore attempted in only a few cases. These resulted in the recovery of the organism from six of the inoculated twigs.

TABLE 1.—*Results of inoculating privet twigs with Glomerella cingulata*

Variety	Part inoculated	Date	Inoculations	Infections	Control incisions	Infections of controls
European	One-year wood	May 1, 1923	10	9	6	0
do	Two-year wood	do	5	5	3	0
do	One-year wood	Aug. 1, 1923	10	10	6	2
Amur	do	do	10	0	6	0
Ibota	do	do	10	0	6	0
Regel	do	do	10	0	6	0
California	do	do	10	0	6	0
European	do	July 4, 1924	7[a]	6	3	0
do	Two-year wood	do	5[a]	4	3	0
do	One-year wood	do	6	6	—	—
do	Two-year wood	do	6	6	—	—
Amur	One-year wood	do	6	0	—	—
do	Two-year wood	do	6	0	—	—
Ibota	One-year wood	do	6	0	—	—
do	Two-year wood	do	6	0	—	—
Regel	One-year wood	do	6	0	—	—
do	Two-year wood	do	6	0	—	—

[a] Inoculated with a culture of *G. cingulata* from apple fruit.

INOCULATIONS OF UNWOUNDED TWIGS

Observations of the disease in nature indicate that the fungus can enter the unwounded tips of twigs. The basal cankers already described apparently originate from basal shoots thus infected or from infection of undeveloped lateral buds.

On August 7, 1923, several inches of the ends of eight growing shoots of European privet were sprayed with a water-suspension of spores and mycelial fragments from culture. Two other shoots were sprayed with water for controls. All shoots were inserted in lamp chimneys plugged at both ends with cotton and left thus covered for forty-eight hours. Four of the inoculated shoots developed die-back, while the other four and the

controls remained healthy. On two of the inoculated shoots small cankers developed some distance back of the tip, indicating that infection may occur in unwounded bark of the current season's growth.

CROSS INOCULATIONS WITH PRIVET AND APPLE

As is indicated in table 1, some of the inoculations of privet were performed with a culture of *Glomerella cingulata* from apple. As apple bitter rot is very rare in this part of Kansas, no culture was at hand. The one used was kindly furnished by Dr. H. W. Anderson, who isolated it from apple fruit in Illinois.

On July 4, 1924, a number of inoculations were made into twigs of Ben Davis and Missouri Pippin apple trees, using the culture of *Glomerella cingulata* from apple and several cultures of the privet fungus. No infections resulted from these inoculations. It seems unwise to delay publication of this article to secure further data on this point. Shear and Miss Wood (3) present a summary of the cross inoculations made with *Glomerella cingulata* by them and by previous investigators. They record no privet-apple cross inoculations.

INOCULATIONS OF APPLE FRUITS

Inoculations of ripe apple fruits were made, using several cultures of the fungus from privet and the apple culture mentioned above. The fruits were surface-sterilized with mercuric chloride, 1 to 1,000, and allowed to dry. A wedge-shaped piece of tissue was removed from each fruit with a sterilized scalpel; inoculum, consisting of mycelium and agar from a culture of *Glomerella cingulata*, was placed in the well thus formed, and the wedge of tissue replaced. The fruits were then covered with bell jars. Control fruits were similarly treated except for the insertion of inoculum. Only a few cases of rot developed in the controls, and in these cases some other organism than *Glomerella cingulata* was responsible.

The results of fruit inoculations (omitting the control fruits) are summarized in table 2. Observations were made when any fruit had reached a stage of total decay. This condition is indicated in the column headed "infection" by six plus-marks. The relative rate of decay of other fruits is indicated by a smaller number of plus-marks. A plus-mark in the column headed "reisolations" indicates that planting bits of decayed tissue in tubes of potato dextrose agar resulted in pure cultures of *Glomerella cingulata*. It is evident from this table that some cultures of *Glomerella cingulata* from privet can cause decay of ripe apples as readily as the apple-strain of the fungus, others much less readily or not at all.

TABLE 2.—*Results of inoculating apple fruits with pure cultures of Glomerella cingulata*

Variety	Culture	Source	Infection	Reisolations
Blacktwig	27	Privet	++++++	+
"	32	"	++++++	+
"	34	"	+	+
"	9	"	+	+
"	33	Apple	++	+
Jonathan	27	Privet	++++++	+
"	9	"	+	+
"	29	"	++++++	+
"	39	"	++++++	*Alternaria* sp.
"	35	"	+++	+
"	42	"	+	*Penicillium* sp.
"	38	"	+	.....
"	17	"	0	.....
"	12	"	0	.....
"	33	Apple	++++++	+
Grimes	27	Privet	+	+
"	9	"	0	.....
"	29	"	++++++	+
"	39	"	++++++	+
"	35	"	+	*Alternaria* sp.
"	42	"	0	.....
"	38	"	++++++	+
"	17	"	0	.....
"	12	"	0	.....
"	33	Apple	++++++	+
York Imperial	9	Privet	+	+
" "	29	"	++++++	+
" "	39	"	+	*Alternaria* sp.
" "	35	"	+	+
" "	42	"	+	+
" "	12	"	0	.....
" "	33	Apple	+++	+
Ben Davis	27	Privet	++++++	+
" "	9	"	+	.....
" "	29	"	++++++	+
" "	39	"	++++++	+
" "	35	"	+	.....
" "	42	"	+	+
" "	38	"	++	+
" "	12	"	0	.....
" "	19	"	0	.....
" "	33	Apple	++++	+

CONTROL

It seems possible that partial control of this disease might be accomplished by spraying. As, however, the use of privet as a hedge plant renders anything short of complete control valueless, no spraying experiments have been attempted.

It seems best to recommend that where the anthracnose is found to be serious other privets be substituted for European (English) privet. The

record of observations and of artificial inoculations reported earlier in this paper indicates that several privets are immune to anthracnose. There is nothing surprising in this immunity as the various privets under consideration are, with one exception, separate species.

The following is a list of the privets most commonly used for ornamental planting. The nomenclature is that of Olmstead, Coville, and Kelsey (2).

Ligustrum vulgare. European privet.
Ligustrum amurense. Amur privet.
Ligustrum ibota. Ibota privet.
Ligustrum ibota regelianum. Regel privet.
Ligustrum ovalifolium. California privet.

European privet is the only one of these susceptible to anthracnose. California privet often winter-kills in this climate, but the others are hardy. Amur and Ibota privets make excellent hedges and seem acceptable substitutes for European privet, at least in Kansas and neighboring states.

SUMMARY

Anthracnose of European (English) privet, caused by the imperfect stage of *Glomerella cingulata*, was first described by Atkinson in 1892.

During the past few years this disease has been observed to be destructive to privet hedges in Kansas City, Missouri, and vicinity.

In addition to the twig-blight and twig-canker seen by Atkinson, girdling cankers at the base of the plant have been found. Such cankers cause the death of the plant, although not always in the same season that infection occurs. The disease is therefore more destructive than is indicated by Atkinson's description.

Isolations from diseased plants have yielded, in most cases, pure cultures of *G. cingulata*.

The fungus agrees in cultural characters and behavior with descriptions given by other investigators.

Wound-inoculations into main stems and twigs of privet plants have shown the fungus to be pathogenic for European privet, but not for Amur, Ibota, Regel, and California privets.

The fungus has been reisolated from inoculated plants of European privet.

One inoculation experiment indicated that spores of the fungus may enter the unwounded tips of growing twigs. Such entrance apparently occurs in nature.

Positive results were obtained when twigs of European privet were inoculated with a culture of *G. cingulata* from apple. One attempt to inoculate apple branches with cultures from both apple and privet failed.

Inoculations into apple fruits indicated that some strains of *G. cingulata* from privet decay apples as readily as does *G. cingulata* from apple, others less readily, and others not at all.

The only feasible remedy for the disease seems to be the substitution of another privet for European privet. Hedge privets suggested for the middle west are Ibota and Amur.

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FLAGELLATES IN PLANTS: A REVIEW OF FOREIGN LITERATURE

MATHILDE BENSAUDE

HISTORY

A Leptomonas, which is a flagellate of the family of the trypanosomides, was found in April, 1909, in the latex of three species of Euphorbia by Dr. Lafont (19), then director of the Microbiological Laboratory in Mauritius. This discovery aroused general interest among protozoologists and specialists in human and animal flagellosis. Lafont named the flagellate *Leptomonas davidi* n. sp. in honor of his assistant David who was the first actually to see the organism. *L. davidi* was reported from several tropical countries soon after Lafont's first publication. In 1911 Dr. Carlos França (6), medical officer and eminent Portuguese protozoologist, found the same flagellate for the first time in Europe parasitizing two species of Euphorbia commonly found in the neighborhood of Lisbon. Euphorbiae invaded by *L. davidi* have been found more recently in Italy (32, 23, 24), Sicily (32), and France (33). In 1916 and 1920 Dr. Migone found two more species of Leptomonas in the latex of milk weeds from Paraguay (27, 9). Finally in a number of hasty preliminary notes (11–18), Dr. Franchini, an Italian physician, now working at the Pasteur Institute at Paris, has described a series of flagellates and amoebae as parasitizing a large number of laticiferous plants, most of them tropical, growing in botanical gardens, either in greenhouses or out of doors.

As can be seen from this brief survey, the presence of flagellates as plant parasites has been reported by a number of authors from many localities, and in several hosts. A considerable amount of work has already been done in this interesting new field, yet, astonishing as it may seem, no contributions have been made by plant pathologists, and, moreover, until very recently the whole matter seems to have been ignored by botanists. The first mention of these plant parasites that we have been able to find in any publication dealing with plant life is the excellent paper by Mesnil (26) in 1921. Since then this subject has been reviewed in the Zeitschrift für Pflanzenkrankheiten by Niesehulz (28) and in the Review of Applied Mycology (1, 2).

FLAGELLOSIS OF EUPHORBIAE

Host range and geographical distribution. A list of the known hosts of *L. davidi*, and the names of localities from which flagellosis has been reported appear in table 1.

TABLE 1.—*Host range and geographical distribution of Leptomonas davidi*

Hosts	Localities from which flagellosis has been reported
Euphorbia pilulifera	Mauritius (19), Madagascar, Mayottes, Madras (4), Zanzibar, Dahomey (3), Senegal (25), Martinique (29), and New Caledonia (26).
E. thymifolia	Mauritius (20), Madagascar, and Mayottes (4).
E. hypericifolia	Mauritius (21), and Madagascar.
E. indica	Belgian Congo (30).
E. peploides	Algeria (31).
E. peplus	Portugal (5), Italy (23) and Sicily (24). (Not infected in Mauritius.)
E. segetalis	Portugal (5), and Italy (32).
E. dulcis, *E. falcata*, *E. nereifolia*, *E. virosa*, and *E. humifusa*	Italy (23).
E. grandis	Sicily (23).
E. schimperiana, and *E. cuponi*	Sardinia (32).
E. helioscopia, L., *E. esula*, and var. *mosana* DC.	France (33).

Symptoms. The different authors do not agree concerning the effect produced on the host by the presence of Leptomonas. Lafont (20) and França (7, 8) believe that the flagellates produce a real disease. Other authors, however, consider the parasite entirely innocuous. Lafont states that in Mauritius parasitized specimens of *E. pilulifera*, for example, can be easily recognized by their debilitated aspect followed by a wilting and yellowing of the leaves. When completely withered, the stems of parasitized plants become thin, brown, and very brittle. França (8) describes similar symptoms for *E. peplus* and *E. segetalis* and also lesions formed around the insect puncture through which the parasites presumably first entered the plant. França (7, 8) confirms Lafont in stating that the presence of the flagellates in the laticiferous tubes may either be general or else strictly localized. In some cases localization is such that a single leaf from a twig may be parasitized while the others are not invaded. França has described and figured the stunting effects of what he calls a heavy infection on growing shoots and the recovery of the plant in cases of light infection. Bouet and Roubaud (3), Rodhain and Bequaert (30), Noc and Stevnel (29), and Léger (25) affirm in contradiction to the above mentioned authors that it is impossible to distinguish invaded from non-invaded plants without a microscopical examination. The contradictory results of authors working in different localities might very possibly be

explained by a careful study of symptomology under varied environmental conditions.

Pathological histology. Studies of pathological histology have been reported by França (8). Flagellates are first found in the necrotic tissue around the insect puncture which the author calls the "primary chanere." Except for this localized region, flagellates are not found outside the laticiferous tubes. The invaded tubes are ordinarily few in number. When invaded, however, they usually contain great numbers of parasites. A clogging of the tubes is often produced due not only to the number of flagellates present but also to the coagulation of the latex. França thinks that the independence of the laticiferous tubes from each other throughout the plant, as well as this process of clogging, might explain to a certain extent the surprising localization of the flagellosis.

According to França the presence of numerous flagellates in the laticiferous tubes gradually leads to a disappearance of starch grains, not only from the latex, which becomes watery and colorless, but also from the neighboring parenchyma cells. The chlorophyll bodies themselves may eventually disappear. In the primary lesion a very marked alteration of the tissues can be seen. There is a dark center of necrotic tissue and beneath this a band of corky cells is often found.

THE CAUSAL ORGANISM: LEPTOMONAS DAVIDI LAFONT

Morphology. Lafont's organism, to which he assigns the binomial *Leptomonas davidi*, is polymorphic, like all trypanosomides. The typical form most commonly found in a smear or hanging drop of invaded latex is an elongated flagellate 16 to 20 microns long and 1.5 to 2 microns wide. The body tapers gradually toward the anterior extremity and is flattened out like a ribbon and twisted two or three times around its axis at the posterior end. In fixed and stained preparations a nucleus with a membrane and small granules of chromatin can easily be detected one third of the total length back from the anterior extremity. A second chromatic body of dense structure and smaller dimension is the kinetonucleus or blepharoplast, found in the proximity of the anterior extremity, from which arises a flagellum 10.5 to 16.5 microns long. In its general structure the organism resembles a simple stagnant water flagellate, such as Cercomonas. The presence of the kinetonucleus at the base of the flagellum, and the absence of a digestive vacuole, however, place it among the parasitic flagellates of the family of the trypanosomides. All members of this family known hitherto are parasitic in the digestive tract of invertebrates (mostly insects) and in the blood of vertebrates.

The multiplication of the parasite in the latex is accomplished by means of a longitudinal binary cleavage. The blepharoplast divides first pro-

ducing two granules, one of which retains the old flagellum, while a new flagellum buds from the other granule (7, 8). The nucleus divides next, and finally the body splits, beginning at the anterior extremity.

Cultures. Attempts to culture the organism have not been successful. On starchy and sugary media, cysts are produced which burst open, and aberrant-looking flagellates are liberated. On extracted latex and on latex agar the organism lives 24 to 48 hours. Flagellates have been cultured for 16 days on the medium of Nicolle (blood agar), and multiplication by binary fission was observed. These colonies, however, died when transferred.

Experiments on the transmission of flagellosis by insects. So striking is the resemblance of the flagellates found in the latex of the Euphorbiae to those commonly parasitic in the digestive tract of insects that from the very first all students of plant flagellosis have searched for the alternate host and transmitting agent of *L. davidi* among the insects commonly found on Euphorbiae. Lafont (22) attempted to transmit the infection by means of the puncture of *Nysius euphorbiae* Horvath, a hemipterous insect feeding exclusively on Euphorbiae. Having allowed a number of starved individuals to feed on heavily infected plants, he succeeded in transmitting the infection to healthy branches of an infected plant and also to an entirely healthy one. Bouet and Roubaud (3), working in Dahomey, found flagellates resembling *L. davidi* in the intestine of another latex-sucking hemipterous insect (*Dieuches humilis* Reuter). Eighty starved Dieuches were fed on heavily infected plants for one week and then placed on six healthy plants for about another week. Twenty days later one of the plants was found parasitized. The authors claim that *D. humilis* is capable of transmitting the infection and is most probably the insect host of *L. davidi.*

França (7), in his publication of 1914, expressed the opinion that the real insect host, the natural source of infection of the Euphorbiae, had not yet been found, no worker having been able to find parasites in the salivary glands of an insect, or to produce infection by punctures from insects found in nature. Later França himself (8) found the insect which proved to be, in Portugal at least, the real alternate host of *L. davidi.* He has been able to produce infection with insects found in nature and to study the complete life cycle of the flagellate both in the plant and in the insect.

The alternate host of L. davidi. The insect host of *L. davidi* in Portugal is a small coreid, *Stenocephalus agilis* Scop. This insect is particulary difficult to observe because of its nocturnal habits. França noticed that flagellates resembling *L. davidi* were often found in the digestive tract

of this hemipteran. He then discovered that on plots of healthy Euphorbiae no parasitized insects were collected, whereas a high percentage of infected Stenocephali were found in localities where flagellosis prevailed. This author has studied infected specimens found in nature as well as Stenocephali fed experimentally on parasitized latex. In this manner he was able to establish the fact that the flagellates found in the intestine of naturally infected insects are identical with those found in the gut of experimentally infected ones.

Development of L. davidi in the insect host. Having captured Stenocephali in localities where flagellosis of Euphorbiae had never been observed, França (8) allowed them to feed on heavily parasitized plants and then killed and examined them. He thus obtained the principal stages in the evolution of the parasite in the insect host. The flagellates found in the stomach of *Stenocephalus agilis* on the first, second, and third days after ingestion of parasitized latex are in active division, by means of binary or multiple cleavage. After the third day, França finds, among others, large multi-nucleated forms that seem to precede schizogony. These multinucleated forms are probably preceded by isogamic conjugation. França figures what he supposes to be a stage in one such process of conjugation. Very small parasites are found about the eighth day all along the intestine, particularly in the mid-gut and also in the salivary glands. These measure from 4.5 to 7 microns long by 0.8 to 1.5 microns wide. Many of them are devoid of a flagellum. These forms are produced in great numbers. When colored by the usual Giemsa method the nucleus and blepharoplast stain intensely, whereas the protoplasm remains very pale. These are, according to França, the really infective forms in the life cycle of *L. davidi*. They are found in the salivary glands of the insect, as well as in the tissue of the plant in the neighborhood of the insect puncture. França, very properly, calls these small forms "metacyclic," because they constitute the link between the life cycle of *L. davidi* in the insect and the life cycle in Euphoribia.

Overwintering. In the mild climates in which flagellosis of Euphorbiae has been found, Leptomonas lives during the winter in the latex of a certain number of plants (8). These plants constitute in spring the source of infection for newly hatched Stenocephali. On the other hand, it is reported that insects having contracted the infection one season are capable of harboring *L. davidi* during the winter. On one occasion, for example, França (8) found the salivary glands of two insects just coming out of hibernation practically swarming with metacyclic forms of quite normal appearance.

Influence of environmental conditions. All recorded observations seem to indicate that warm and dry conditions are necessary to the development of flagellosis of Euphorbiae.

Single or multiple origin of L. davidi. It is not possible on present evidence to state whether the Leptomonas of Euphorbiae found in different parts of the world belong to one species or whether they are simply forms of convergence of several species of insect Leptomonas adapted to the latex of Euphorbiae. It is theoretically difficult to conceive how convergence could produce forms not only similar, but apparently identical, as those found by Lafont and França (8). If, however, *L. davidi* is primarily an insect parasite, as seems probable, and if Stenocephalus, the primitive host of *L. davidi* in Portugal, does not exist in tropical countries, as it has been claimed, we shall be forced to believe that the same species of Leptomonas can parasitize several genera of insects, or else that different strains of *L. davidi* are of different origin. Laveran and Franchini (23) bring experimental evidence that seems to indicate that insect flagellates, when introduced into the latex of Euphorbiae, not only live in this new medium, but have the tendency to become similar to *L. davidi*. These authors claim to have actually produced typical flagellosis by injecting a pure culture of an intestinal parasite of the dog flea (*Herpetomonas Stenocephali*) into several specimens of two species of Euphorbiae. The authors claim that flagellates recovered from the latex of the inoculated plants had become different from those in the pure cultures, having acquired the twisted bodies characteristic of all plant Leptomonas known hitherto.

FLAGELLOSIS OF SOUTH AMERICAN MILK WEEDS

In 1916 Dr. Migone (27) found a Leptomonas in the latex of a climbing milk weed (*Araujia angustifolia*) growing in the marshes of Paraguay. All the plants growing in one locality were found to be parasitized, yet presented no symptoms of disease. The flagellates gradually disappeared from the latex of specimens removed to another part of the country. The new flagellate was named by Migone *Leptomonas elmassiani* n. sp. This protozöon is so transparent that its presence in a drop of latex can be detected only by the movement of the starchy granules. Colored slides show that *L. elmassiani* resembles *L. davidi* in structure, but is usually smaller. Dr. Migone succeeded in culturing the parasite on blood agar. Little is known concerning the life cycle and transmission of the flagellate. *Onchepeltus lactuosus* is the only insect that was ever found feeding on the plants. In the gut of this Hemipteran, Migone observed round parasites, containing a nucleus and a blepharoplast, which might very well belong to the life cycle of *L. elmassiani*.

In 1920 Dr. Migone found a new Leptomonas parasitizing another milk weed (*Morrenia odorata*). In this case also the flagellate appeared to be harmless to the plant. Material was sent by Dr. Migone to França, who has described the parasite and named it *Leptomonas bordasi* n. sp. (9). The organism resembles *L. davidi*, but is slightly larger.

FLAGELLATES AND AMOEBAE FOUND IN LATICIFEROUS PLANTS

Franchini has found with astonishing frequency parasitic protozoa in a large number of laticiferous plants belonging to several different families. Beyond the statement that heavily infected plants are usually yellow and poor in latex, he says very little of the appearance of the invaded plants (14). The author has studied mainly smears of latex. In a few plants, however, cross sections of fruits, leaves, and twigs were made, and stages of multiplication of the parasites inside cells of different tissues were found (14, 16, 18). From the latex the author describes small Trypanosomes and Herpetomonas (=Leptomonas) 8 to 20 microns long, extremely variable in size, and, to judge by the hasty sketches, often very aberrant in shape. These flagellates show marked amoeboid movements and curious involution forms, particularly under adverse conditions such as low temperature (11). In the latex of most plants he finds also amoebae of different sizes, varying considerably in structure from one host to another.

By using Noeller's blood agar, Franchini has succeeded in culturing parasites of *Chlorocon whitei* (17), *Ficus parietalis* (18), *Ficus carica* (15), *Strophantus regalis* (14), *Strophantus scandens* (14), *Antiaria toxicaria* (14), and of various Euphorbiae (16). He states that a study of the cultures proves conclusively that the flagellates and amoebae belong to the same cycle. It seems to us that in order to prove this point cultures started from a single protozöon would be most desirable. Franchini has found that amoebae from the latex of the fig (15) and a few other hosts, when cultured on blood agar, ingest blood corpuscles (14), behaving like pathogenic amoebae in the intestinal wounds of a patient suffering from amoebean dysentery, and differing therein from trypanosomides, which are known to depend entirely on osmotic exchanges for intake of nutritive material. The author finds that bacterial contamination has an inhibiting effect on all the parasites (14).

Franchini has not yet been able to study the modes of infection and life cycles of any of the many forms which he has discovered. Roaches, plant lice, flies, and even spiders are suspected of being the alternate hosts (11, 14).

Although hasty, this series of preliminary notes by Dr. Franchini

opens a very remarkable field to investigation, showing that the presence of protozoa in laticiferous plants is very general indeed.

In order to make this review of literature more nearly complete, mention should be made of a paper by Dr. Franchini (13) in which he reports a case of cabbage flagellosis. In smears made from yellow cabbage leaves on which numerous Hemiptera had been feeding, he finds flagellates similar to those found in the intestines of the insects. From such observations he announces that he has found a flagellosis of cabbage. The evidence, however, is not convincing, as the technique does not entirely preclude the possibility of contamination of the smears from insect excreta present on the leaves.

It is hoped that Dr. Franchini will, in the near future, supplement his notes by a detailed and careful study of the numerous protozoa which he has reported.

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ALTERNARIA SOLANI AS A CAUSE OF TUBER ROT IN POTATOES

DONALD FOLSOM AND REINER BONDE

WITH PLATES V TO VII

In the extensive literature upon the early blight of potato caused by *Alternaria solani* (E. & M.) J. & G., the writers have failed to find any mention of the occurrence of tuber rot attributed to this fungus. In his monograph upon early blight, Rands mentions tuber infection only in relation to a certain hypothesis of interseasonal perpetuation. He states (1, p. 32) that he has "no evidence to substantiate," and sees "no reason for accepting the hypothesis offered by Massee and endorsed by McAlpine that the disease is transmitted from one generation to another by latent mycelium in the tubers." The writers infer that Rands also had no evidence of tuber infection of the rot type. The present paper is submitted as being of interest and importance in regard to the effects of the early blight organism on potatoes.

In March, 1922, a small lot of Spaulding Rose potatoes was received from an experienced grower in central Maine who did not recognize the nature or cause of certain spots found on tubers taken from a storage bin. One of these tubers is depicted in plate VII, fig. A. A visit by the senior writer to the bin in question disclosed considerable bruising and rot, the latter apparently of the Fusarium dry-rot kind, and but very few examples of the spots in question. Enough material, however, was secured to permit a few isolations, nineteen of which gave cultures of a certain type. Of these nineteen similar cultures, some produced spores characteristic of *Alternaria solani* (Plate V, Fig. A), and seventeen of them, when grown on potato agar, caused the typical discoloration of the medium described by Rands (1, p. 20), yellow at first, changing to reddish. Two of the nineteen cultures caused no discoloration, although the mycelium and spores were typical for the species in question.

About a year previous, several tubers with similar spots had been noted during the planting season and planted separately. No cultures were made from these tubers. There were no effects upon the vines. The tuber progeny of the vines showed no spots. Because of this, and because other problems were more pressing at the time, nothing further was done in 1922, except to assure the maintenance of some of the culture strains in stock. In January, 1924, Dr. L. O. Gratz, of the Florida Agricultural

Experiment Station, sent a similar lot of Spaulding Rose potatoes showing various degrees of injury from the small lesions or spots to complete decay. He stated that the trouble seemed to be of considerable importance in seed sent from Maine to Florida. A somewhat similar lot, mostly in an advanced stage of decay, came from the same region in Florida on seed tubers of the same variety, through a visitor from Maine. Isolations by the writers yielded various fungi, including several species of *Fusarium*, the latter being found especially in the more advanced stages of decay, and also yielded a number of cultures of *Alternaria solani*. These cultures produced a few spores even with ordinary methods and, with one exception, discolored the agar.[1] Spores were also obtained in abundance *in vitro* from the mycelium by shredding the agar as suggested by Rands (2). At this time it was possible to attempt inoculations of plants and tubers.

SYMPTOMS IN THE TUBERS

The spots or lesions usually are darker than the healthy skin and appear somewhat sunken, sometimes surrounded by a slightly raised border (Plate VII, Figs. A and B; Plate VI, Figs. C and D). Their outline may be circular or irregular. The lesions are nearly always shallow (Plate VI, Fig. D) and small, rarely exceeding a centimeter in diameter, and the transition from diseased to healthy cortical tissue often is abrupt enough that it is easy to lift out the infected portions intact. Apparently the invasion of new tissue by the parasite often ceases, and is slow when it continues after the first stage (Plate VII, Figs. B and C). When *Alternaria solani* was recovered from large lesions, other fungi were usually associated with it. That these fungi were not the initial cause of the decay is indicated by their miscellaneous nature and by their absence from the small apparently primary lesions.

ARTIFICIAL INOCULATIONS

The first inoculations were made on Green Mountain tubers and plants during March and April, 1924. The mycelium, with the normal scarcity of spores, was rubbed upon the surface of young tubers freshly dug in the greenhouse. This was done at various times. Infection frequently resulted, usually at the lenticels, but also where needle pricks had been made and sometimes at the eyes (Plate V, Fig. B). The fungus was recovered from the resulting lesions and was used to make similar lesions on other tubers. Tuber controls upon which sterilized mycelium was rubbed or which were untreated remained healthy even when in the same damp

[1] Dr. Gratz has reported, orally to the writers, similar results from isolations made in Florida. He also examined the manuscript for this paper before its submittal for publication.

chamber (Plate V, Fig. B). For further confirmation of identification, the mycelium, both before the inoculation of the tubers and also after being recovered from them, was rubbed upon the surface of the leaves of small but rather mature plants grown in the greenhouse. Early blight had not been observed during the last six winters under these greenhouse conditions where the floors are of concrete, the application of steam heat is sometimes continuous during the day throughout the winter, and the air consequently is apparently quite dry as a rule. Here it was difficult to secure infection in the open greenhouse by inoculation. However, infection with the mycelium was readily obtained under bell jars in which the air was humid (Plate V, Fig. C). Control plants and uninoculated control leaflets and leaves on the same plant remained healthy (Plate V, Fig. C). Infection sometimes was so severe that yellowing, collapse, and death occurred within a few days after the spots appeared. It may be pointed out here that in a similarly humid atmosphere, namely, in Bermuda, similar rapid devastation has been reported by Whetzel (3). With spores obtained *in vitro*, also, no foliage infection was obtained in the open greenhouse, but it was readily secured under bell jars. Here, again, yellowing and collapse often occurred (Plate VI, Figs. A and B). But where the amount of inoculum applied was not excessive, spotting occurred, resembling somewhat in distribution upon the leaves conditions seen in badly infested fields. However, the characteristic target-board zonation was not so apparent, and lesions also occurred on the petioles and stems, again resembling the effects seen in Bermuda (3, p. 101). Spores were readily obtained from the diseased foliage, confirming the identification made *in vitro*.

Reference has been made to the occasional discovery of cultures or strains that were non-chromogenic with respect to potato agar. A preliminary comparison was made between chromogenic and non-chromogenic strains in regard to pathogenicity, and, incidentally, between strains of 1922 and those of 1924. Greenhouse plants were inoculated with the mycelium of four strains: chromogenic, isolated in 1922; non-chromogenic, isolated in 1922; chromogenic, isolated in 1924, and non-chromogenic, isolated in 1924. No difference was apparent in the resulting infection of the foliage.

In order to determine the natural method of infection, spores, instead of the mycelium, were applied to young tubers by means of an atomizer. The results were similar to those obtained with the mycelium. Isolations were made from the lesions, and the cultures produced spores of *Alternaria solani*.

FIELD INOCULATIONS

In the late summer of 1924, diseased Irish Cobbler foliage and somewhat immature Spaulding Rose tubers were packed together at various times. Usually abundant lesions resulted (Plate VI, Figs. C and D; Plate VII, Fig. B). When controls consisted of tubers not packed in the leaves, no infection occurred. Sometimes such a control was divided after infection had appeared in the corresponding inoculated tubers, and part of the control was inoculated in the same way, with similar positive results. When well-sprayed, comparatively healthy foliage was packed with the tubers, only a few lesions appeared. All platings made from lesions soon after their appearance yielded pure cultures of *Alternaria solani* (Plate VII, Fig. C).

These results suggest the possibility of infection of freshly dug tubers from contact with diseased foliage. In Maine, digging is necessarily often done before the vines are all dead, or within a few days after the vines have been killed wholly or in part by low temperature. The death of the vines in the former case may be hastened by early blight. Therefore diseased foliage often comes into contact with freshly dug, somewhat immature tubers which are more or less bruised by the time they are put into storage (Plate VII, Fig. A).

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DESCRIPTION OF PLATES

PLATE V

FIG. A. Photomicrograph of spores of *Alternaria solani* as usually secured from cultures in these experiments. X 400.

FIG. B. (I) Young Green Mountain tuber inoculated and infected with the mycelium of *Alternaria solani* cultures isolated from tuber lesions. (C) Control.

FIG. C. (I) Leaf of Green Mountain greenhouse plant inoculated and infected with the mycelium of *Alternaria solani* cultures isolated from tuber lesions. (C) Control.

PLATE VI

FIG. A. (I) Green Mountain plant inoculated and infected with *Alternaria solani* spores obtained *in vitro* from cultures isolated from tuber lesions. (C) Control. Compare with fig. B.

FIG. B. (I) Leaves from the inoculated plant of fig. A. (C) Leaf from the control plant of fig. A. The small spots are caused by thrips.

FIG. C. Infected Spaulding Rose tuber photographed soon after being packed in diseased foliage. Compare with fig. D.

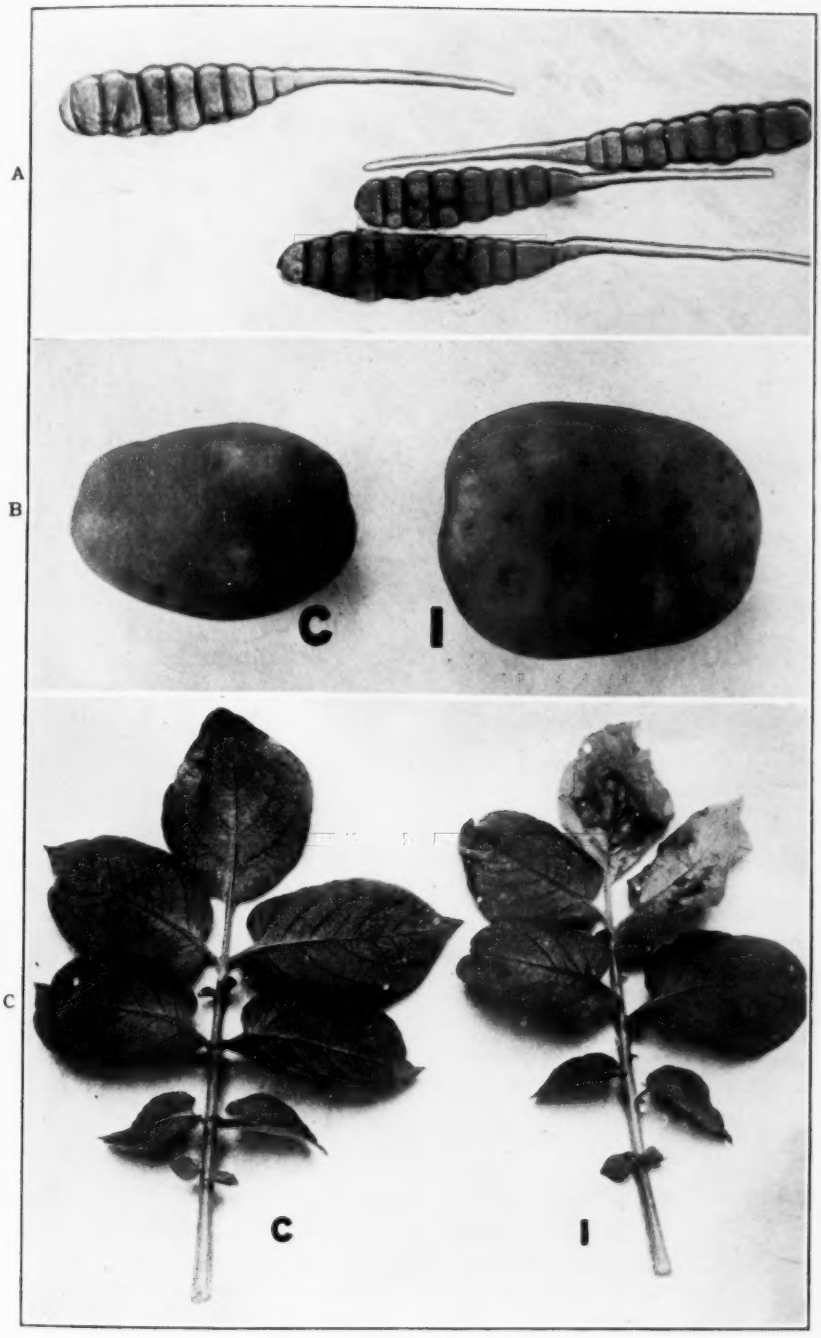
FIG. D. Infected Spaulding Rose tubers cut to show the shallowness of the lesions. Photographed soon after infection resulting from being packed in diseased foliage. Compare with fig. C.

PLATE VII

FIG. A. Spaulding Rose potato with early blight lesions occurring where the skin has been partly rubbed off, probably during digging. Photographed in March, 1922, after the tuber had been in cold storage through the winter. Compare with fig. C.

FIG. B. Infected Spaulding Rose tubers photographed soon after being packed in diseased foliage. Compare with fig. C.

FIG. C. The same tubers as of fig. B, after about two months, not in cold storage. The scars were caused in the process of isolating the fungus. Compare with fig. A.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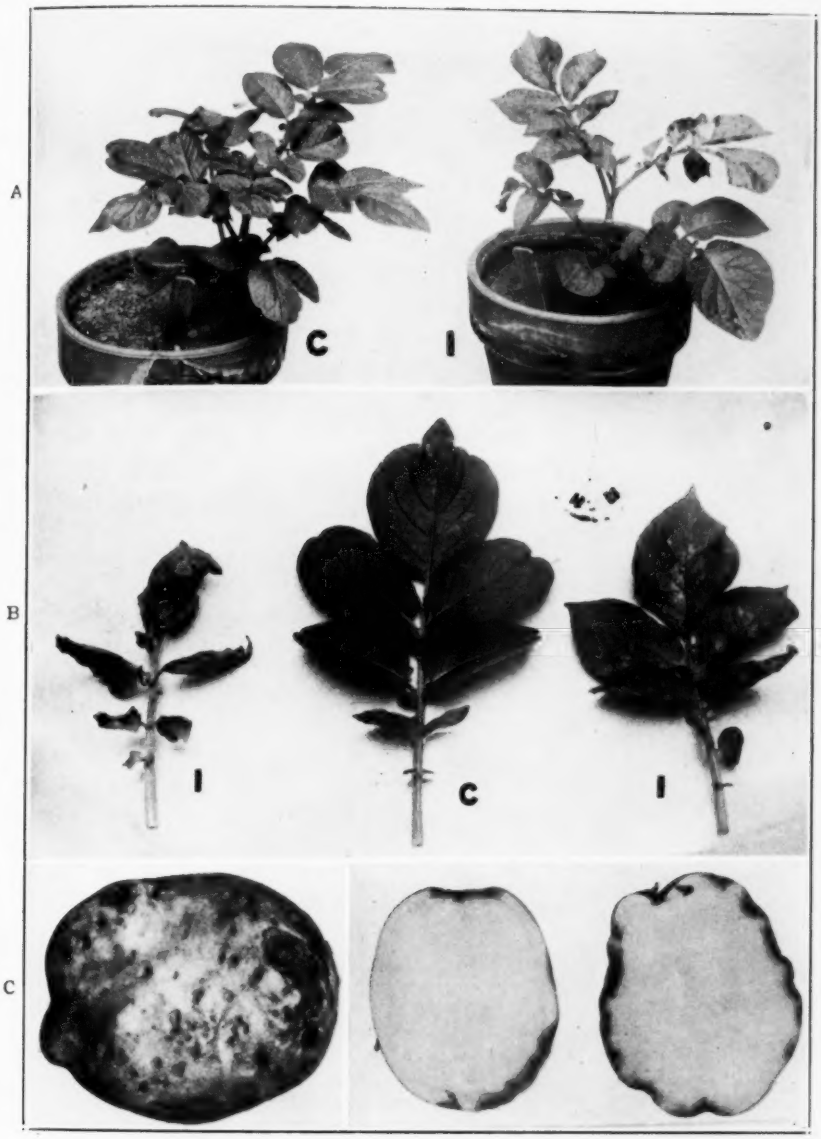
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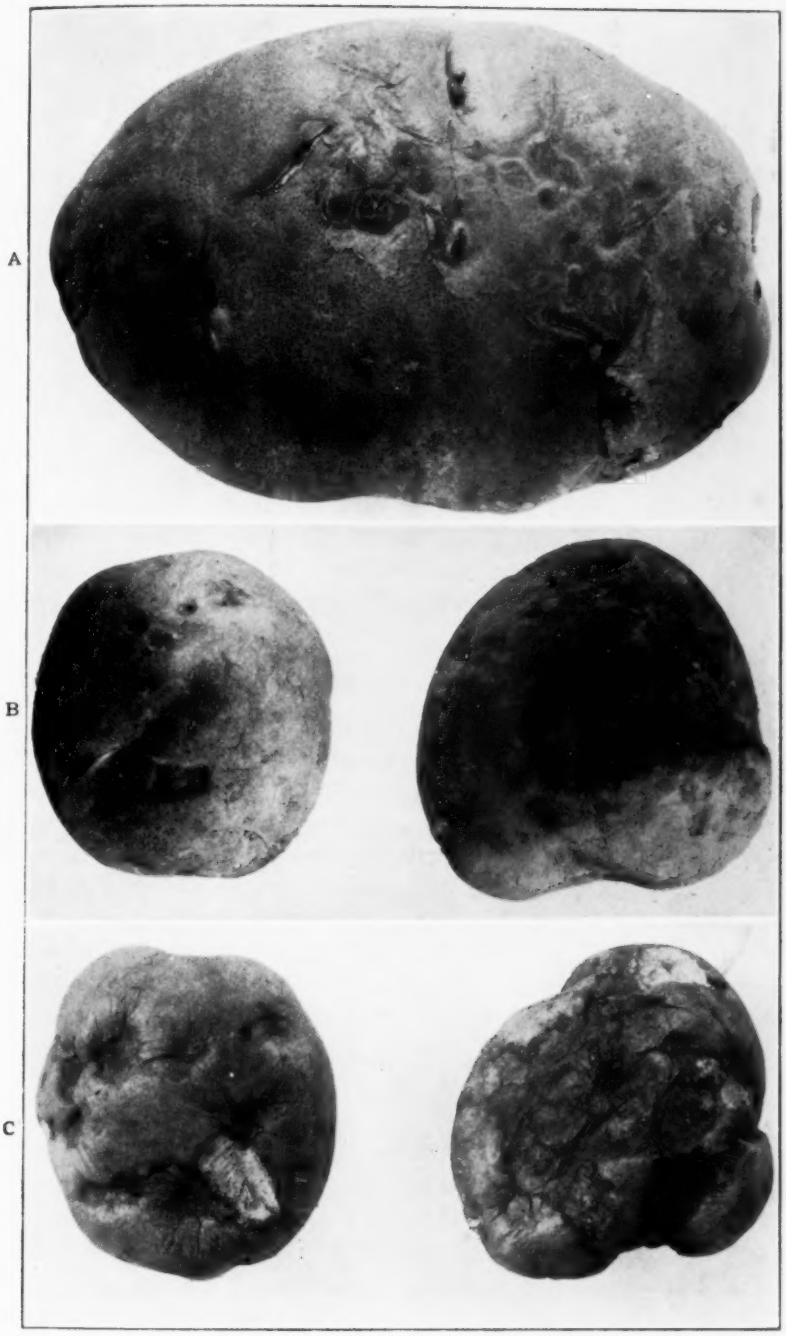
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THE RELATION OF SOIL MOISTURE TO THE POX OR GROUND ROT DISEASE OF SWEET POTATOES

R. F. POOLE[1]

WITH FOUR FIGURES IN THE TEXT

During the last four years, results of observations on the prevalence of the pox or ground rot disease of sweet potatoes (Figs. 1 and 2) caused by the slime mold, *Cystospora batatas* E. & H., show that it was worse in dry than in wet seasons, notably so when there was drouth in June and July. A very striking demonstration at the Vineland Training School farms on experimental plots showed slight infection in the dry season of 1921, no infection in the wet season of 1922, and severe infection in the very dry season of 1923. In severely infested soils in the Swedesboro locality, the disease causes nearly a total failure of the crop in dry seasons, but on the same soil in wet seasons fair to nearly normal yields are produced. These results suggested that some rather definite information might be obtained by studying the relation of soil moisture to the disease under controlled conditions in the greenhouse.

REVIEW OF LITERATURE

A review of literature on the pox disease showed no definite record of the moisture relations of the disease. As the result of field observations, a number of workers, including Halsted (3), Duggar (2), Adams (1), Poole (4, 5), and others, reported that the disease was worse in dry than in wet seasons. Halsted said, "In a dry season the plant is less able to push ahead and overcome the attack, and therefore the yield is light and the rot appears more abundant. That the season may be favorable will always be a hopeful element in the grower's calculations." Taubenhaus (6) comes to a different conclusion by saying, "In wet weather pox is just as severe, and the causal organism perhaps more active, but the spots are more shallow and less noticeable."

METHODS USED IN CONDUCTING THE EXPERIMENTS

The soil, a sassafras sand, in which 85 per cent poxed sweet potatoes were produced in 1921, was obtained near Mickleton, New Jersey. It was sieved to remove stones and débris and air-dried in the greenhouse all winter. One-gallon glazed pots were used for the Vineless Yellow Jersey

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variety, and two-gallon pots for the Triumph variety, nearly filled with 7,000 and 10,000 grams of well mixed dry soil, respectively. The water-holding capacity of the soil taken from two parts of the same field was determined by use of Hilgard pans and found to be 18 and 20 per cent. When water was added to 7,000 and 10,000 grams of air-dried soil until it was so well saturated that a slight excess of water remained on the top, approximately the same percentage was obtained as with Hilgard's pans. The range of moisture was then prepared on the basis of the water-holding capacity of the soil (Fig. 3).

The soil used in these experiments, being sandy and of a low water-holding capacity, remained loose throughout the experiment. The moisture percentages were maintained satisfactorily by weighing the pots at intervals of from one to three days, depending on weather conditions, and adding water to make up the weight lost. After finding that the water diffused readily and quite evenly in the high moisture pots, and that very little watering was required to keep the low moisture percentages normal, no effort was made to sub-irrigate or retain moisture with surface coverings. Three sprouts were set in each pot in order to obtain a large number of feed roots, "feed roots" meaning those which do not become potatoes or storage roots.

FIG. 1. Pox or ground rot disease of sweet potatoes. Note deep markings of spring and early summer infection, and small shallow spots of late summer and early fall infection.

EXPERIMENTAL RESULTS

Experiment I was a preliminary test to determine if the organism remained active after air-drying the soil. This work was conducted from October 1, 1923, to February 1, 1924, using the Big Stem, Red, Vineless and

Yellow Jersey, Dooley, Nancy Hall, Porto Rico, Triumph, Red Brazil, and White Yam varieties. The roots of all of these varieties were attacked, but the Jersey varieties were most severely attacked. The results showed that the parasite remained very active, and that the Triumph variety, though less severely diseased, produced a very good root system, even in very dry soil. In view of this fact, the Triumph and Vineless Yellow Jersey varieties were selected as being more suitable for pot studies than some of the other varieties.

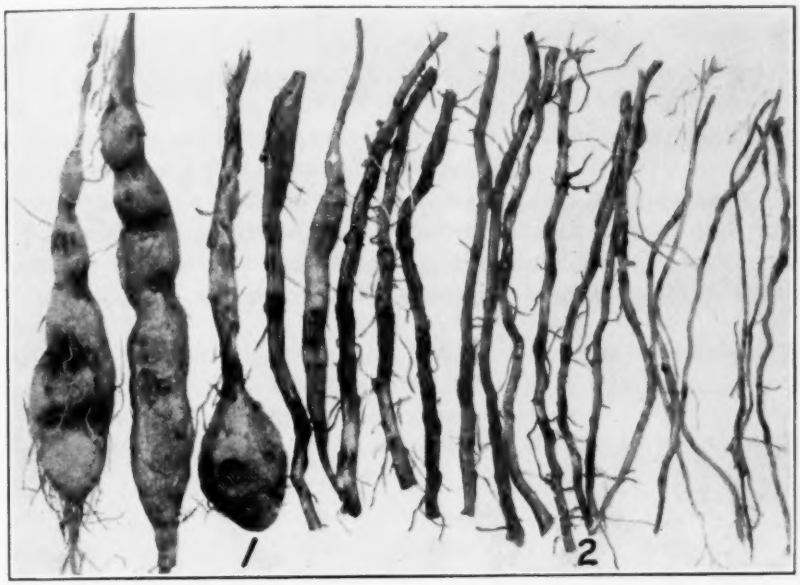

FIG. 2. (1) Potatoes severely poxed. (2) Roots showing wide variation in infection and size of spots.

Experiment II was conducted with the Triumph variety with a 2, 5, 10, 15, and 20 per cent moisture range from April 29 to October 2, 1924, when the plants were harvested. In order to recover as much of the root system as possible, the pots were rolled until roots and soil were emptied together. The roots still attached to the plants were then separated from the soil and 25 roots (not potatoes) were selected from all parts of the three plants in each pot and examined to determine the number of poxed spots. The average results from three plants in each treatment are given in table 1, which shows that there was no infection at saturation and 15 per cent moisture, based on the water-holding capacity. There was slight infection at 10 per cent, and very severe infection at 5 and 2 per cent.

TABLE 1.—*The influence of soil moisture on the development of pox*

Moisture per cent (saturation)	Roots examined No.	Roots poxed No.	Poxed spots total No.
20	25	0	0
15	25	0	0
10	25	5	15
5	25	19	85
2	25	31	121

In order to demonstrate that the soil was infected in the high moisture pots and to determine if a sudden drought favored infection, the moisture in one series of pots was permitted to drop to 2 per cent. After 14 days, the results, given in table 2, show that a change from high to low moisture brings about a favorable condition for infection, which became so severe as nearly to destroy the root system. A larger number of poxed spots were produced on roots of plants grown in 5, 10, and 15 per cent than in 2 per cent moisture. The difference is due to the fact that a greater root area was developed and exposed to infection in the higher moisture pots.

TABLE.—*Influence on pox development of suddenly changing the soil moisture from a high to low percentage*

Moisture per cent	Roots examined No.	Roots poxed No.	Poxed spots total No.
20*	25	25	83
15	25	25	147
10	25	25	254
5	25	25	638
2	25	25	145

* The plants were grown in the original percentages of moisture. From September 18 to October 2, they were all maintained at 2 per cent moisture.

Experiment III was conducted with the Vineless Yellow Jersey. Its short vines made it very convenient for handling in pots, and the strain also was very productive of roots. The object of this experiment was the same as in the previous one, but with less increments in the moisture range and more cultures. The plants were set June 12 and harvested August 25. The average results in table 3 show a gradual increase in infection from high to low moisture content, there being no root infection in saturated soil and very slight infection above 12 per cent. The disease was strikingly severe on roots in 6 and 4 per cent moisture, some being blackened for almost the entire length (Fig. 3), due to coalescing of poxed spots. Many

of the roots broke off and completely rotted away, especially after being girdled (Figs. 1 and 2). It was impossible to get a complete count of the total number of poxed spots on roots in pots having a low moisture content, as many of the roots were girdled, broken off, and rotted. The potatoes in the 8, 6, and 4 per cent moistures were severely poxed, while in the higher

FIG. 3. Moisture range, type of pot used for the Vineless Yellow Jersey variety.

moisture content no infection was observed (Fig. 4). The maximum root growth and also the greatest total dry weight were obtained between 10 and 16 per cent moisture, indicating that the most favorable moisture condition for producing the sweet potato crop is above that favoring severe pox infection.

TABLE 3.—*Influence of soil moisture on the development of the Vineless Yellow Jersey Strain*

Moisture (saturation)	Roots poxed No.	Total poxed spots No.	Potatoes raw yield gms.	Vine and roots dry weight gms.
18	0	0	3.4	9.03
16	5	6	31.1	18.74
14	9	12	31.1	20.33
12	16	35	35.1	17.88
10	24	80	25.1	16.14
8	21	84	22.8	14.33
6	24	239	5.2	6.31
4	25	362	.7	2.30

CONCLUSION

The results obtained above suggest irrigation, which might be profitable on the best types of sassafras sand. They also suggest the addition of organic matter to the soil, either through the plowing under of cover crops or the addition of large quantities of organic matter until the soil becomes less susceptible to drought. Furthermore, different methods of culture, especially different depths of planting, should be studied, as well as depths of plowing the land.

FIG. 4. Plant on the left showing healthy white roots and potatoes grown in 16 per cent moisture. Plant on right showing diseased, severely blackened roots, grown in 6 per cent moisture.

SUMMARY

1. The pox, ground, or soil rot disease, *Cystospora batatas* E. & H., of sweet potatoes, *Ipomoea batatas*, is most severe in dry seasons.

2. The disease attacks the Big Stem, Red, Vineless and Yellow Jersey, Triumph, Dooley, Nancy Hall, and Porto Rico varieties, being most severe on Jersey varieties. The parasite remained very active in spite of the soil being thoroughly air-dried all winter before using it for these tests.

3. The Triumph variety was not attacked at 15 to 20 per cent moisture, the latter being the water-holding capacity of the soil used. It was attacked slightly at 10 per cent and severely at 5 and 2 per cent. Decreasing the moisture to 2 per cent for 14 days resulted in severe infection of all roots that had grown in the high moisture percentages.

4. The Vineless Yellow Jersey showed no infection in saturated soil (18 per cent), and very slight infection above 12 per cent. While there was a high percentage of infection at 8 per cent, it was most serious at 6 and 4 per cent. Maximum production of potatoes as well as of vines and roots was between 10 and 16 per cent, being above the critical point of infection.

5. The results suggest the use of irrigation and the addition of organic matter to make the soil more resistant to drought. They also suggest that different depths of plowing and planting should be studied.

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NON-PATHOGENICITY OF THE MILKWEED FLAGELLATE IN MARYLAND

FRANCIS O. HOLMES[1]

It has been repeatedly affirmed by European authors that the flagellates of the Euphorbias cause pronounced symptoms when they are numerous in the latex of the plants. The leaves become yellow and are easily detached from the twigs, the latex becomes watery and contains little or no starch. Later the latex may even disappear completely.

Observations made in the autumn of 1923 seemed at the time to indicate that Maryland milkweeds (*Asclepias syriaca* L.) showed similar symptoms when herpetomonad flagellates of the species *Herpetomonas elmassiani* (Migone) were present in their latex. At that season the herpetomonads were always very numerous if present at all, and several accidental circumstances seemed to point to the pathogenicity of the flagellates.

It happens that flagellates are found almost entirely in seed-bearing plants. These mature early and are already yellow when non-fruiting plants are still green. Their latex becomes clear and watery as the pods mature, and the leaves drop early leaving the pods alone on the bare stalks. By the time of the actual maturity of the seeds, no latex is to be obtained from the plant. These normal changes late in the season in accidental association with the latex-inhabiting flagellates seemed to parallel European findings as to the starving effect of large numbers of herpetomonads in the latex cells.

It was necessary to study the plants through the spring, summer, and autumn, as was done in 1924, before the effect of the flagellates could be distinguished from the effect of approaching maturity.

EARLY INFECTIONS RARE

Early in the summer a search was made for plants showing flagellates in their latex, but such plants were much rarer in May and June than they were in September and October.

The milkweeds in Maryland pushed up their young shoots from overwintering rootstock buds about the third week of May. A few days later a series of latex smears taken from a hundred scattered plants showed just one to be infected. At this time the plants were not more than a foot and a half high. A week later several additional positive plants were found, not

[1] Joint contribution from the laboratories of the Boyce Thompson Institute for Plant Research and of the Department of Medical Zoology, School of Hygiene and Public Health, Johns Hopkins University.

scattered among the various groups examined, but all in the single group in which the first infected shoot had appeared. These few young plants were already heavily infected.

LACK OF EXTERNAL SYMPTOMS

Throughout the summer these heavily infected individual plants were carefully compared with the more numerous negative shoots of the same group, as well as with negative plants of other groups, until it became evident that no external differences could be found between the plants whose latex contained many flagellates and those whose latex contained none.

Late in the season, as the seed pods approached maturity, the flagellate-containing plants began to lose their leaves, the latex became watery and contained little besides the flagellates themselves. But the plants containing no flagellates followed precisely the same course. The changes were merely autumn modifications. It was impossible after close study to distinguish the infected plants from the others by their external appearance.

França (1) observed that in an infected Euphorbia the presence of *Herpetomonas davidi* in one of two otherwise similar twigs caused a cessation of growth in the infected portion, so that soon the shoot which was free from flagellates had grown far longer than the one in which they were living. The height of the infected milkweeds in Maryland was therefore carefully compared with that of their neighbors which arose from the same root stock but were free from organisms. No difference in height, size of stems or leaves, or numbers of seed pods could be detected. *Herpetomonas elmassiani* seems to be non-pathogenic in the milkweed, *Asclepias syriaca* L.

The case for *Herpetomonas davidi* in Euphorbias is not quite so clear. Lafont (2), França (1), and more recently Strong (5) observed striking changes when the flagellates were present in numbers.

On the other hand, Léger (3), Rodhain and Bequaert (4), and others insisted that it was impossible to predict which plants would prove positive on microscopical examination of the latex and which would prove negative. Perhaps their infections were lighter, or their plants more resistant. It is even conceivable that they were not dealing with the same flagellate species as França's and Lafont's. The specific name "davidi" has been applied to Euphorbia flagellates from countries very widely separated geographically, and sufficient measurements have not been made to determine whether or not the organisms observed by different investigators have been properly named. It may be that some of the flagellates of the Euphorbias, even when present in enormous numbers in the latex, are really non-pathogenic, just as *Herpetomonas elmassiani* in milkweed has shown itself to be.

CONCLUSION

Herpetomonas elmassiani (Migone) may be present in the latex of the milkweed, *Asclepias syriaca* L., in very large numbers without appearing to interfere with the normal growth of the plant or to modify the leaves, stems, or seed pods.

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GEOGRAPHICAL DISTRIBUTION OF THE MILKWEED FLAGELLATE, HERPETOMONAS ELMASSIANI (MIGONE)

FRANCIS O. HOLMES[1]

WITH ONE FIGURE IN THE TEXT

The latex-inhabiting plant flagellate, *Herpetomonas elmassiani* (Migone), was first discovered in the milkweed, *Araujia angustifolia*, in Paraguay in 1916. In 1923 a form morphologically indistinguishable from it was found in the latex of the milkweed *Asclepias syriaca* L. in Maryland. This suggested a possible wide distribution of the flagellate along the Atlantic coast, a matter of some interest as material for class use and for research had not previously been known to exist in the United States. Slides received by the kindness of Dr. R. W. Hegner, of the School of Hygienic and Public Health, Johns Hopkins University, indicate that in the latex of *Asclepias curassavica* L. at Tela, Honduras, the same flagellate abounds. This record from Central America will probably be followed by others from intermediate points along the Atlantic coast of North America and of South America.[2]

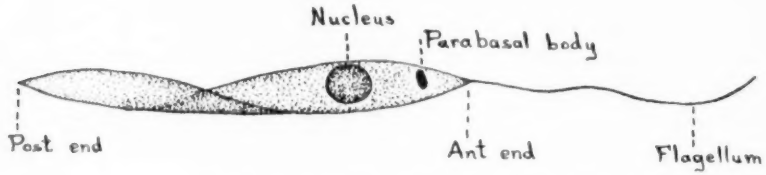
Within the United States, the location in Maryland was the only one known in 1923. The following year an attempt was made to find the northern limit of the range of the flagellate. In the early part of the summer infected milkweeds were rare, but in September, 1924, when the organisms were most widespread in Maryland, the survey was started. Among five hundred milkweeds examined in Massachusetts, a few more than two hundred were bearing fruit at the time, but all were negative for *Herpetomonas elmassiani*. The plan of the investigation was to start with this location in New England and to search northward if the location proved positive, but southward if it proved negative, until the boundary of the normal range of the flagellates should be found. As the Massachusetts survey gave negative results, a series from New York State, collected at Yonkers, N. Y., was examined. About the same proportion of fruiting plants was included, one hundred and ninety-nine out of the five hundred bearing seed pods at the time of collection. All were negative.

At the end of September three hundred and fifty plants were examined in Maryland to determine the exact proportion of positive plants there. Seventeen and one-half per cent of *all* the milkweeds collected contained

[1] Joint contribution from the laboratories of the Boyce Thompson Institute for Plant Research and of the Department of Medical Zoology, School of Hygiene and Public Health, Johns Hopkins University.

[2] The species has since been found in material collected in Haiti by Dr. L. O. Kunkel of the Boyce Thompson Institute for Plant Research.

flagellates. Among those which were fruiting a higher percentage obtained, fifty-nine per cent being positive. On the other hand, only five per cent of the non-fruiting plants contained the organisms. On this account, in later surveys only plants in fruit were examined, as they offered by far the most favorable chance for discovering the herpetomonads. The occasional occurrence in non-fruiting plants may have meant that infection took place at blossoming time but that seed pods did not develop, or that the fruiting top of the plant was cut or broken off in midsummer with the resulting growth of non-fruiting side shoots. The insect most closely associated with the positive plants, *Oncopeltus fasciatus* Dallas, seemed to be confined to the blossoms and fruit of the milkweed.



A diagrammatic representation of a typical specimen of the latex inhabiting flagellate, *Herpetomonas elmassiani* (Migone), taken from material collected in New Jersey. x 4000.

The next step was to study an intermediate point between Maryland, where the flagellates were common, and New York, where they were not to be found. At Bound Brook, N. J., thirty miles southwest of New York City, and hence about forty-five miles from the negative area examined at Yonkers, N. Y., a survey in early October yielded four per cent of positives. This narrowed the doubtful area to northern New Jersey, and gave a hint that the range of the flagellates might correspond with the normal range of the insect mentioned above, as the latter has been collected within twenty-five miles of New York City, but never has been recorded in New York State.

A location was chosen at Closter, N. J., just across the Hudson River from the negative area at Yonkers, N. Y., and within a few miles of the New York line which defines New Jersey on the east and north. There, on account of the frosts, very few fruiting plants could be found. Yet three plants among the first eighteen collected were positive for the latex-inhabiting *Herpetomonas elmassiani*.

A table of measurements is shown herewith to indicate the morphological identity of the New Jersey flagellate with the species as previously obtained from southern locations. A diagrammatic representation of a typical flagellate is given in the accompanying figure.

On account of repeated examinations of milkweeds on the New York side of the Hudson River and of the absence of the suspected insect carrier,

TABLE 1.—*Average measurements of Herpetomonas elmassiani from New Jersey, compared with measurements of the species as found in southern locations*

	Paraguay Measurements given by França, 1921	*Honduras*	*Maryland*	*New Jersey*
Length of body	12–15μ	13.2μ	12.2–15.6μ	13.1–14.4μ
Anterior end to parabasal body	1.5	1.3	1.2– 1.8	1.3– 1.6
Parabasal body to nucleus	1.5	1.3	1.4– 2.2	1.4– 1.8
Length of nucleus	1.5	1.7	1.5– 2.1	1.6– 2.0
Posterior end to posterior margin of nucleus	7.5–10.5	8.6	7.2–10.7	7.6– 9.8

Oncopeltus, from the negative regions studied, it seems likely that northern New Jersey is the limit of the range of the flagellate along the Atlantic coast.

CONCLUSION

Herpetomonas elmassiani (Migone) previously known to occur in Maryland, was found to be present in the latex of milkweeds (*Asclepias syriaca* L.) as far north on the Atlantic coast as the northern boundary of New Jersey, within a few miles of the Hudson River. Points in New York State and in Massachusetts were examined without positive results.

ABSTRACTS OF PAPERS PRESENTED AT THE SIXTH ANNUAL MEETING OF THE CANADIAN DIVISION OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY, OTTAWA, ONTARIO, CANADA, DECEMBER 22–23, 1924

Plant pathology in Canada. B. T. DICKSON.

Presidential address, mainly devoted to a review of the pioneer efforts in the field of plant disease work in Canada. Early publications, (1857 on), investigations, teaching, and legislation were embodied and brief consideration was given to recent developments. The address is appearing in Scientific Agriculture for March, 1925.

Some notes on diseases new to Ontario. J. E. HOWITT.

During the summer of 1924, the following new diseases were found in Ontario: Rose Canker, caused by *Coniothyrium werusdorffiae* Laubert, probably synonymous with *Coniothyrium fuckelii* Sacc.; Twig Canker of Elms, thought to be due to *Gnomonia ulmea* (Schw.) Thm.; Celery Yellows caused by an undescribed species of *Fusarium;* Anthracnose of Lettuce caused by *Marssonia panattoniana* (Berk) Mag.

Root rot or blight of canning peas. R. E. STONE.

The root rot and blight of canning peas is doing a large amount of damage in that part of Ontario east and north of Toronto. During the past season an aggregate of more than six hundred acres of canning peas was completely destroyed. Many other fields show partial loss. The growers report the following varieties as being especially susceptible to the disease: Rogers Winner, Alaska, Perfection, Surprise, Thomas Laxton, Advances, Market Gardener, First Earlies, White Admiral, and Horsford. These are the standard canning varieties.

Test plots have been run on certain selections of peas and there is hope of securing peas of good canning quality that are resistant to this trouble. Horel, a hybrid variety developed in Wisconsin, is quite resistant and certain selections developed in Michigan also show promise. The work will be continued the coming year.

Taxonomic studies of the organism causing black-dot disease of potato. B. T. DICKSON.

Comparing descriptions and specimens it appears that the organism should be known as *Collctotrichum atramentarium.* It is closely similar to *C. maculans* (*V. maculans*), differing only in spore shape. Cultural studies indicate that, while isolations from Quebec, England, France, Pennsylvania, Ohio, and W. Virginia are of the same organism, there is physiological specialization as well as saltation in it. A full account will appear in PHYTOPATHOLOGY and Mycologia.

Winter blight or streak in tomatoes. R. E. STONE.

This disease of tomatoes has proved troublesome in Ontario for a number of years. The disease is associated with an excess of nitrogen in the soil and deficient potash and phosphoric acid.

Good results in the control of this disease in commercial greenhouses have been obtained by increasing phosphoric acid and potash content of fertilizers applied under cultivation.

Oat smut control tests at Macdonald College during 1924. B. T. DICKSON.

Hulless oats were again artificially inoculated with both smuts. Weather conditions were adverse both at seeding and harvest so yield was not considered. The best results were obtained by using nickel dusts. Typical counts are given in the table below.

Results of treating hulless oats with various fungicides for the control of oat smut

Treatment	Culm count of 3 replicas.	Smutted Heads	Clean Heads	% Smut
No control treatment	2972	1752	1220	58.4
Nickel sulphide dust	2623	22	2601	0.8
Nickel carbonate (H. F. & G.)	2458	41	2417	1.66
Nickel hydrate by caustic ppt[n].	2369	41	2328	1.7
Copper carbonate.	2453	52	2401	2.1
Nickel hydrate by lime ppt[n].	2995	70	2925	2.5
Presoak and formalin	2458	81	2377	3.3
Uspulum soak	3344	114	3230	3.4
Semesan dust	2322	148	2174	6.0
Semesan soak	3105	198	2907	6.4

Nickel dust at rate of 3 ozs. per bu. of grain.

A mycologist at large. JOHN DEARNESS.

This subject was treated in a popular manner from two points of view; the pursuit of interests in fungi as hobbies with mycophagical and with histological objectives and as an applied science in the hand of the trained plant pathologist. Fungi, as shown by illustrative examples, are as ubiquitous and vary as greatly in shape, size, structure, nutrition, and reproduction as other kinds of plants. Their commonplace and curious uses as food and medicine were related. Persoon's account of his beneficial experience from subsisting on the peasants' coarse bread, raw fungi, and simple water was cited.

Physicianship to plants is almost the youngest of the professions. Beginning with Dr. J. C. Arthur's appointment at the Geneva, N. Y. Experiment Station in 1884, the rise and progress of professional plant pathology was briefly outlined.

The injury to economic plants from the two important causes, insects and fungi, may, for reasons that were enumerated, be estimated as nearly equal. This basis of estimate, supported by other considerations, showed that an annual loss to Canada of $100,000,000 from fungal (including bacterial) plant diseases would be a very conservative estimate. The loss, whatever it may be, can never be wholly averted; nor can an estimate be made of what professional plant pathology is worth to the country now, or will be in the future. Everyone who has, even only superficially, looked into the subject must believe that Canada is only beginning her duty and opportunity in the matter.

An annotated list of the anthracnoses of plants in Canada and the United States was also presented. The list contains fungi of the following genera—*Gloeosporium, Colletotrichum, Marssonia, Septogleum, Cylindrosporium.*

Experiments on sex with mushrooms and toadstools: A report of the work of Irene Mounce, William F. Hanna and Dorothy E. Newton. A. H. REGINALD BULLER.

A description of: (1) the Dry-needle method for making monosporous cultures of Hymenomycetes; and of (2) the Cover-glass Method for obtaining the four spores of a single basidium so that they may be picked up one by one and be sown separately in hanging drops of the culture medium. In the genus *Coprinus* some species, *e.g.*, *Coprinus sterquilinus*, *C. stercorarius*, and *C. narcoticus* are homothallic (Mounce) while other species are heterothallic. Of the heterothallic species: (1) some, *e.g.*, *C. Rostrupianus*, are bisexual and each basidium bears two spores of one sex and two spores of the opposite sex (Newton); while (2) others, *e.g.*, *C. lagopus* (Hanna) and *C. curtus* (Newton) are quadrisexual. In *C. lagopus* some of the basidia bear spores of only two kinds, two of one sex and two of another and opposite sex; while other basidia bear spores of four kinds, each one differing in sexual constitution from the other three. In this fungus, reduction takes place in the basidium during the second division of the fusion nucleus. Two pairs of Mendelian factors are involved in the sexual process. (Lantern Slides).

A study of decay in the balsam fir. A. W. MCCALLUM.

During the summer of 1923, a study of decay in balsam fir was carried out in Quebec. The particular area selected was on the Shipshaw River on the limits of Price Brothers and Company. Here 532 trees were felled upon selected quarter-acre plots so as to secure an average of conditions in the stand, and complete notes were taken for each tree upon all points which might be of value. Two decays of importance were met with: red heart rot due to *Stereum sanguinolentum*; and feather rot, a butt rot probably caused by *Poria subacida*. The characteristics of these decays are described. In balsam fir cut for pulpwood, no other cause of cull but decay occurs. A direct relation was found to exist between age and decay. Starting from zero in the 51–60 year age class the amount of cull steadily increases until in the age class 181–190 it amounts to 40% of the merchantable volume. Although there is a general impression to the contrary, no relation of importance was found to exist between the present condition of balsam fir in regard to decay and the recent budworm outbreak.

A bacterial disease of tomatoes new to British Columbia. H. R. MCLARITY and T. M. C. TAYLOR.

A bacterial disease of tomato is reported as appearing for the first time in British Columbia. Its extent is considered very limited, but in the worst affected plot approximately 75 per cent of the crop was lost. A sudden wilting of leaf or leaflet without change of color is the first evidence of the disease. Shrivelling, browning, and defoliation of the affected tissue, and the appearance of small, sunken, brown areas and some longitudinal cracks on the leaf petiole or stem are later characteristics. The causal organism was isolated and some ninety-two successful inoculations were made on healthy plants. Cultural and morphological characteristics were studied, and it is considered by the writers that the pathogene is identical with that described by Dr. Erwin F. Smith as *Aplanobacter michiganense*. Details of the experiment are to be found in the annual "Report of the Dominion Botanist, 1924."

Oat smut infection in relation to size of grain. J. G. COULSON and E. A. LODS.

Preliminary experiments, carried on at Macdonald College during 1924, to ascertain the relationship between size of kernel and resulting infection, when using oats artificially

inoculated with *Ustilago avenae* (Pers.) Jens. and *Ustilago levis* (K. & S.) Mag., indicate, without exception, that a greater percentage of infection results by using small kernels as compared with large kernels. In order to make this evident with Banner and Alaska oats the seeds were de-hulled before inoculation. That de-hulling is necessary is shown in the table in the case of Banner. While the germination of the small kernels was not quite so good as that of the large kernels, the difference was not sufficiently marked to modify the results in the table below.

Experiments to test relations of size of oat seed to infection with smut.
Summary of 1924 results

A. Field tests with Ustilago levis (K. & S.) Mag.—five replications for each test

Variety	Condition of grains	Weight per 100 seeds in grams		Per cent infection by plants	
		Large	Small	Large	Small
Avena sativa var. Banner (4707)	De-hulled	2.94	1.44	19.11 ± .5	35.46 ± 2.02
Avena sativa var. Banner (4707)	Hulled	3.97	1.66	2.01 ± .42	1.75 ± .57
Avena sativa var. Alaska (412)	De-hulled	2.99	1.40	10.95 ± .809	40.73 ± 1.42
Avena nuda var. Liberty (0–480)	Hull-less	3.17	1.41	40.84 ± 3.397	66.14 ± 1.478

B. Greenhouse tests with Ustilago avena (Pers.) Jens.

Avena nuda var. Liberty (0–480)	Hull-less	.....	.....	32.1	54.84
Avena nuda var. Liberty (0–480)	Hull-less	.....	.....	2.00	10.10
Avena nuda var. Liberty (0–480)	Hull-less	.....	.....	36.23	46.70

REPORT OF THE SIXTEENTH ANNUAL MEETING OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The sixteenth annual meeting of the society was held at Central High School, with headquarters at the New Ebbitt Hotel, Washington, D. C., December 29, 1924, to January 1, 1925. The attraction and convenience of the nation's capital as a meeting place, the fact that many members are permanently headquartered there, and the increased growth of the Society during recent years resulted in a record attendance. An accurate count of the number of members present could not be made, but it is estimated that from 200 to 225 persons, practically all of them members, attended the various meetings.

Fewer papers than usual were presented, probably owing to the fact that titles and abstracts were due November 1, which was two months before the meeting and one month earlier than in other years. Forty-four papers were presented at the regular sessions of the Society and an additional five were contributed to the joint session with the Mycological Section of the Botanical Society of America, making a total of 49 papers as compared with 114 in 1923, 79 in 1922, and 97 in 1921. The abstracts of these papers were distributed at the meetings and later published in PHYTOPATHOLOGY (Phytopath. **15**: 44–60. Jan., 1925). A popular summary of the facts brought out in the papers has appeared in connection with the report of the Permanent Secretary of the American Association for the Advancement of Science (*Science* **61**: 266–267. March 6, 1925).

At the usual joint session with Section G of the American Association, which was held Tuesday afternoon, December 30, four papers were presented as follows: The Origin of the Cycads, by J. C. Chamberlain, retiring vice-president of Section G; Root Studies, by J. E. Weaver; Soil Nutrients, by E. J. Kraus; and Mosaic and Related Diseases, by L. O. Kunkel.

The extension pathologists held an afternoon session at which ways of bringing plant disease control methods into common use were discussed informally, and the subjects of seed treatment and orchard spray service were considered in some detail. The conference was attended by about 55 persons and considerable interest was shown in the program and discussion.

On Wednesday morning, December 31, many of the members accepted the invitation of the pathologists in the Bureau of Plant Industry to visit them in their offices and laboratories, and about 100 persons took advantage of the opportunity to visit the Arlington Farms in Virginia. Three simultaneous sessions, one on vegetable diseases, one on cereal diseases, and one on fruit and miscellaneous diseases were scheduled for Thursday morning, January 1. These sessions were all well attended and active discussion took place at each.

The closing event of the meeting was the Phytopathologists' dinner and entertainment at the New Ebbitt Hotel the evening of January 1. At this meal, 316 persons were served, this being 160 more than at Cincinnati in 1923, and 200 more than at Boston in 1922. The entertainment consisted for the most part in a minstrel show staged by some of the Washington members.

OFFICERS AND REPRESENTATIVES

The following officers were chosen, the first four elected by the Society and the others selected by the Council and approved by the Society.

President, C. W. Edgerton, Agricultural Experiment Station, Baton Rouge, La.

Vice-president, M. F. Barrus, N. Y. State College of Agriculture, Ithaca, N. Y.

Councilor (two years) Wm. Crocker, Boyce Thompson Institute for Plant Research, Yonkers, N. Y.

Representative on Board of Control of Botanical Abstracts (four years), G. R. Lyman, University of West Virginia, Morgantown, W. Va.

Councilors, representing Divisions of the Society, W. T. MacClement, Queen's University, Kingston, Ontario, Canada, representing the Canadian Division; W. T. Horne, University of California, representing the Pacific Division; C. A. Ludwig, Agricultural Experiment Station, Clemson College, S. Car., representing the Southern Division.

Members of the Editorial Board of Phytopathology (chosen by the Council), *Editor-in-chief* (three years, E. C. Stakman, University of Minnesota, St. Paul, Minn. *Editors* (three years), J. G. Leach, University of Minnesota, St. Paul, Minn; L. R. Hesler, University of Tennessee, Knoxville, Tenn. *Associate Editors* (three years), D. L. Bailey, Manitoba Agricultural College, Winnipeg, Manatoba, Canada; H. W. Anderson, University of Illinois, Urbana, Ill.; B. B. Higgins, Agricultural Experiment Station, Experiment, Ga.; W. H. Tisdale, U. S. Department of Agriculture, Washington, D. C.; S. M. Zeller, Oregon Agricultural College, Corvallis, Ore.; B. T. Dickson, Macdonald College, Quebec, Canada; A. W. Henry, University of Minnesota, St. Paul, Minn.; C. A. Ludwig, Agricultural Experiment Station, Clemson College, S. Car.; L. W. Durrell, Colorado Agricultural College, Fort Collins, Colo.

Business Manager (one year), R. J. Haskell, U. S. Department of Agriculture, Washington, D. C.

Advertising Manager (one year), J. F. Adams, Agricultural Experiment Station, Newark, Del.

Representatives on the Council of the American Association for the Advancement of Science (one year),G. P. Clinton, Agricultural Experiment Station, New Haven, Conn.; and W. A. Orton, Tropical Plant Research Foundation, Washington, D. C.

Representatives on the Council of the Union of Biological Societies (one year), C. L. Shear, U. S. Department of Agriculture, Washington, D. C., and E. C. Stakman, University of Minnesota, St. Paul, Minn.

Members of the Advisory Board (3 years), J. E. Howitt, Ontario Agricultural College, Guelph, Ontario, to replace J. H. Faull; F. C. Meier, U. S. Department of Agriculture, Washington, D. C., to succeed R. J. Haskell; and M. F. Barrus, N. Y. State College of Agriculture, Ithaca, N. Y., to succeed himself.

Member Board of Governors of the Crop Protection Institute (three years), selected by the Advisory Board and approved by the Council and Society, N. J. Giddings, University of West Virginia, Morgantown, W. Va. The other two representatives are C. R. Orton and M. F. Barrus.

The following temporary committees which served throughout the meeting were appointed by the President: *Resolutions Committee*, N. J. Giddings, P. J. Anderson, and J. F. Adams; *Auditing Committee*, G. L. Peltier and Chas. Chupp; *Elections Committee*, C. S. Reddy and C. A. Ludwig.

REPORT OF THE SECRETARY-TREASURER, 1924

At the Cincinnati meeting, 88 new members were elected, which brought the total membership up to 645. However, during the past year 31 members were suspended for non-payment of dues, 6 resigned and 2 died, making a loss of 39, bringing the total membership in good standing December 20, 1924, down to 606. Of the 606 members, 102 were life sustaining and 504 regular members. Ten life members were paid up in full December 20, 1924. At the Washington meeting, 59 new members were elected making the present total membership 665.

The accompanying chart (Fig. 1) shows the annual growth of the Society since its beginning in 1910, when it started with 130 charter members. It will be seen that there has been a steady growth in membership with noticeable increases in 1920 and in 1924 and 1925. The figures in parentheses indicate the number of life sustaining members each year. The secretary has been unable to determine the exact number of members in 1911.

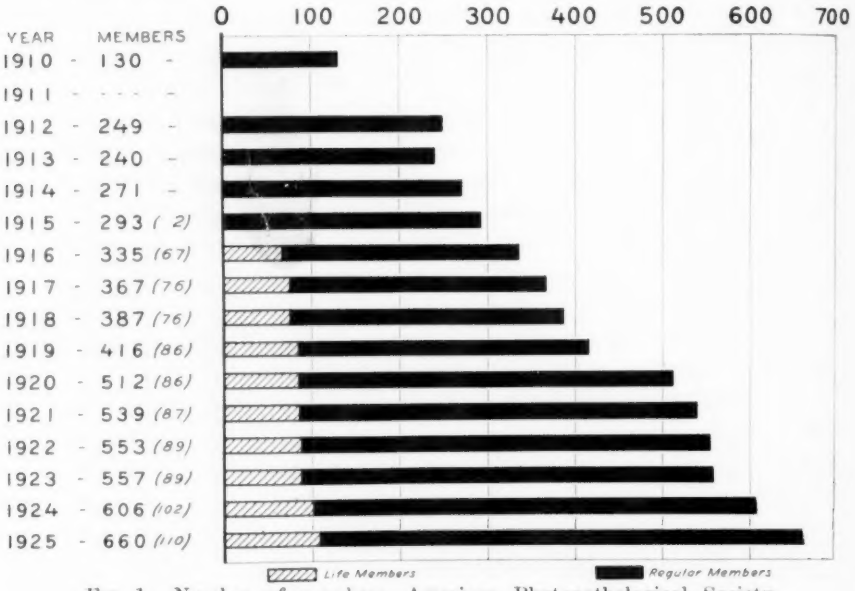


FIG. 1. Number of members, American Phytopathological Society.

Statement of Accounts for 1924, as of December 20, 1924

Receipts:

Balance from 1923	$1,501.84
Annual dues	3,256.55
Cash returned by Secretary-Treasurer on trip to Cincinnati	16.52
Sales received with annual dues	20.50
Excess dues	10.90
Interest on checking account	27.70
	$4,834.01

Expenditures:

Amount transferred to sinking fund for investment	$ 490.00
Secretarial work	209.25
Postage stamps	15.92
Account books, telegrams	3.10
Excess dues returned	3.00
Secretary-Treasurer's travel and miscellaneous expenses	100.00
Expenses of Committee on International Botanical Congress	109.82
Expenses of Program Committee for 1924 meeting	34.32
Expenses of President to Pan-Pacific Food Conservation Conference	200.00
Subscriptions for 1923 donated to European countries	44.02
Sales transferred to PHYTOPATHOLOGY (received with dues)	20.00
Subscription to Oberly Memorial Fund	3.16
Stationery, stamped envelopes, printing	96.88
	$1,329.47

Balance		$3,504.54
Outstanding check		34.32
		$3,538.86
Time deposit of $500 and interest		540.20
		$4,079.06
Amount of above receipts credited on 1925 and 1926	$2,004.51	
Sinking fund:		
Amount due for 1922	$ 5.00	
Amount due for 1923	5.00	
Amount due for 1924	35.00	45.00
Amount due PHYTOPATHOLOGY for Vol. XIV to European Pathologists	40.00	
Amount due PHYTOPATHOLOGY for member subscriptions	2,000.00	
		$4,089.51
Deficit for 1924		$10.45

REPORT OF THE BUSINESS MANAGER OF PHYTOPATHOLOGY FOR 1924

The closing year has been the most prosperous in the history of PHYTOPATHOLOGY. The balance of $3,105.95 reported herewith is the largest the journal has ever had. The receipts have exceeded those of any other year and the amount of printed matter put out has equalled that of 1918 when the record number of pages were published.

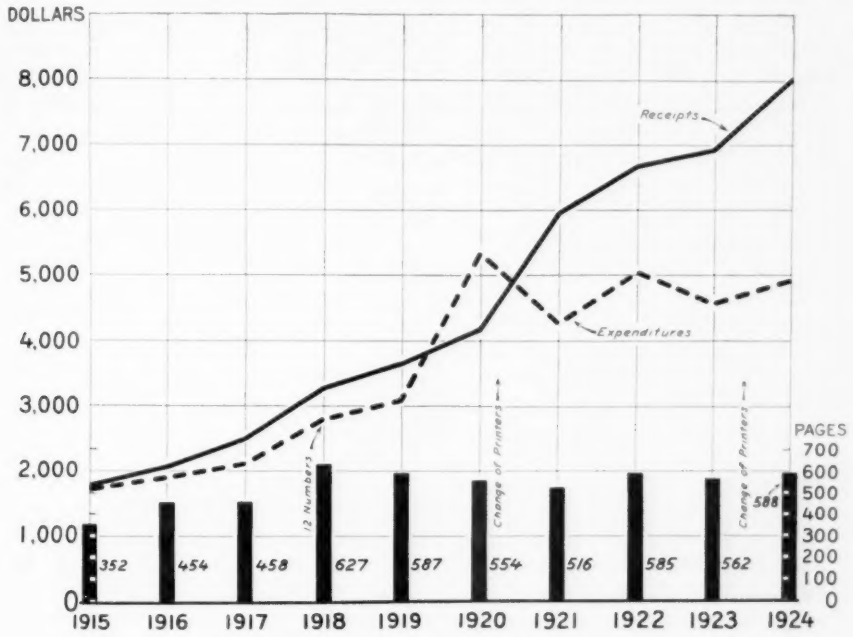


FIG. 2. Receipts and expenditures of PHYTOPATHOLOGY, 1915–1924

The accompanying graph (Fig. 2) shows the receipts and expenditures for PHYTOPATHOLOGY over the ten-year period 1915–1924. The figures used as a basis for the chart were taken from the various annual reports of the business manager as printed in PHYTOPATHOLOGY, and are the same as the totals given there, except that certain additions or subtractions have been necessary on account of items relating to loans, sinking fund, etc., which often appear in both the receipts and expenditure columns. The graph shows a steady increase of income from year to year and also a general increase in expenditure. From 1915 to 1919 the receipts kept pace with expenditures, but during 1920 printing costs mounted so rapidly that in that year a deficit was incurred, it costing $5,329.00 to print 554 pages. To meet the emergency there was borrowed from the treasury of the Society $1,375, and at the Chicago Meeting $1,059.72 was subscribed by the membership. A change of printers was negotiated and the business management took over many of the services for which the publishers were formerly paid. These services included the handling of all subscriptions and advertisements, the sale of back numbers, and the care of mailing lists. The beneficial result of these changes is very evident from the diagram. Since 1920 the journal has not only met its obligations but has been steadily accumulating a surplus until this year it has amounted to slightly over $3,000.

Statement of Accounts for 1924, as of Dec. 20, 1924

Receipts:

Balance from 1923		$2,270.37
Subscriptions		2,381.11
Sales		400.60
Advertising, 1923		89.80
Advertising, 1924		607.49
Interest on invested sinking fund		232.48
Balance due sinking fund to March 7, 1924		490.00
Subscriptions for Europeans for 1923		44.02
Principal of Phelps mortgage note paid up		500.00
		$7,015.87

Expenditures:

Manufacturing PHYTOPATHOLOGY:			
Vol. XIII, No. 11	$ 300.51		
Vol. XIII, No. 12	344.58		
Vol. XIII, Index	153.50		
		$798.59	
Vol. XIV, No. 1	405.30		
Vol. XIV, No. 2	384.25		
Vol. XIV, No. 3	352.30		
Vol. XIV, No. 4	312.80		
Vol. XIV, No. 5	278.25		
Vol. XIV, No. 6	248.36		
Vol. XIV, No. 7	374.00		
Vol. XIV, No. 8	312.43		
Vol. XIV, No. 9	218.56		
Vol. XIV, No. 10	264.52		
Vol. XIV, No. 11	311.65		
Engravings for Vol. XIV	338.78		
		$3,801.20	
			$4,599.79

Miscellaneous expenses, (Dix lists)	56.75	
Second class postage on PHYTOPATHOLOGY	12.03	
Secretarial work	54.00	
Printing Phytopathological Abstracts	93.30	
Postage	19.00	
Expressage, freight, packing, etc.	46.93	
Expenses of Business Manager to Lancaster, Pa.	14.56	
Postage on back volumes shipped by Dr. C. E. Temple	8.77	
Sinking fund invested with accrued interest	1,003.79	
Miscellaneous expenses, account books	1.00	
		$5,909.92
Balance		$1,105.95
Amount of 1925 subscriptions included in above receipts		599.09
		$ 506.86
Amount due PHYTOPATHOLOGY from Society for member subscriptions		2,000.00
Actual balance for 1924		$2,506.86

Members may be interested in noting the various sources of income to PHYTOPATHOLOGY and the relative amounts of each extending over a period of years. With this in mind Fig. 3 has been prepared. It will be seen that the greatest source of revenue is the subscriptions from institutions and non-members. Next in importance come the subscriptions from members. This is followed by receipts from advertising which have been increasing steadily during the past four years, and finally by sales of back numbers of the Journal. The income from all of these sources increased greatly after the change of management in 1921.

During the year 1924, a second change of printers has taken place and PHYTOPATHOLOGY is now being printed by the Science Press Printing Company of Lancaster, Pennsylvania. In December, 1923, a bid was received from the Science Press quoting rates considerably lower than those we were then paying. This offer was taken up with the Council at the Cincinnati Meeting, and also by correspondence during the early part of 1924, with the final result that the change of printers was authorized. It was estimated at that time that the saving which could be effected by the change might amount to about $800 per year.

The change was made commencing with Volume 14, Number 5, and at the same time two decided improvements were instituted. In the first place, a higher grade of paper was substituted for that used formerly. This paper makes the text figures much better and is very satisfactory for plates. With the cheaper paper it was formerly necessary to print the plates on separate paper and insert them by hand, an expensive process for which we paid $10 for one plate, $17 for two plates, $24 for three plates, etc. By putting the plates on the same stock that is used throughout the Journal, they can be printed for $1.95 each, which alone represents a saving that offsets the increased cost of the higher grade paper, and, in addition, we have better text figures and a neater appearing journal in all respects. In the seven numbers printed by the new printers, from May to November inclusive, there have been twenty plates for which we have paid $39. With the other paper we would have paid from $150 to $200.

The other important improvement is an increase in the size of the type page, which was increased from 4½ x 7 to 4 2/3 x 7½ inches, resulting in the obtaining of 3½

square inches more printed matter per page. The new printers have put out 377 of these larger pages which represent an increase of about 40 pages in actual reading matter and for which we would have paid about $150 if put on the small sized page.

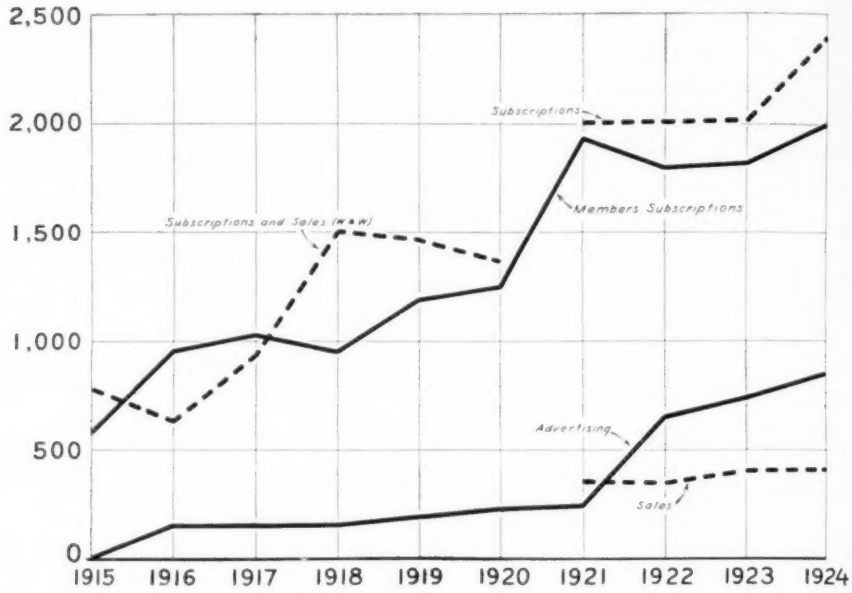


FIG. 3. Receipts from subscriptions, sales of back numbers, members subscriptions, and advertising, 1915–1924

Other economies that have resulted from the change have been figured from the bills for the seven numbers, May to November, when compared with bills from the old printers for the same months during 1923. This comparison shows the following savings:

Mailing list corrections	$ 26.74
Authors alterations	54.70
Discount of 2% for paying bills within 10 days	43.95
Saving on covers	58.80
Total	$ 184.19

To this may be added $135 for saving in cost of printing plates and $150 for the 40 pages of additional printed matter, making a total saving of $469.19 on the seven numbers or a corresponding saving of $804 on twelve numbers.

REPORT OF THE EDITOR-IN-CHIEF OF PHYTOPATHOLOGY

One year ago I resigned as Editor-in-Chief of PHYTOPATHOLOGY. Evidently, like the premature report of the death of Mark Twain, it was not considered a matter to be taken seriously. That resignation was made advisedly, as the conditions which made it necessary have caused undue delay in the publishing of papers in our Journal. This situation is bound to become increasingly worse. Owing to the uncertainty as

to when a new Editor-in-Chief would take over the duties of the office, a number of matters have been allowed to drift along which should have been decided before this time. A year ago I gave a resumé of editorial events for the preceding three years. It remains to bring things up to date. During the year 1924, the fourteenth volume of PHYTOPATHOLOGY has been published. It contains 588 pages of text, 106 figures, and 31 plates. During the year we have begun using a calendared paper which is well adapted to use for plates throughout the Journal. This does away with the need to glue in plates, which has been done when a different paper is used for plates, as was formerly done. Although the paper costs more than the old paper, its use actually costs less than was the case formerly, because of this saving of hand work. It is now possible to make text figures of just as good quality as the plates were formerly. Thus illustrations can be placed in the text where they can be most effectively referred to by the reader.

A year ago attention was called to the increasing patronage of our Journal by foreign contributors. Since that time the Society has definitely committed itself to the assumption of an international status by agreeing to publish papers within our field which are written in English, French, or German. An Editor for Europe, Dr. H. M. Quanjer, Wageningen, Holland, has been appointed, and the first papers published under this agreement appeared in the November number. Beginning with the new year, the international status of the Journal will be indicated on the front cover. These are the public editorial features of our entry into the field of international science. The duties of the Editor-in-Chief have been made heavier and more complicated by this innovation. He must be, even more than in the past, in fact as well as in name, Editor-in-Chief.

Finally, I wish to call attention to a matter or rather group of matters which it seems to me will ultimately be of the greatest importance to this Society. Its decision I believe is vital. It is what I choose to call "ethics." It has assumed so much importance with the foresters that they have a subdivision for it in their literature and it is receiving earnest and sober thought by them. It has not appeared as early with us, possibly because we have less direct connections with commercial interests, but it has reached the point where we can no longer ignore it. It is appearing more especially in connection with commercial interests, but there are other angles to the problem which tend toward undermining the very spirit of scientific research, which means unbiased investigations if it means anything. No one who has followed American literature in plant pathology during the last few years (or indeed the literature in any other science) can have failed to notice the increasing disregard for the published work of others. In certain lines of work there seems to be a concerted ignoring of papers published before 1910. While this is true of American literature, it is even more true of foreign literature, whether it be in English or in other languages. I believe every one of us knows workers who do this deliberately. It is one of the most alarming symptoms of the general demoralization which has followed the war. A scientific investigator who ignores antecedently published work connected with his problem lays himself open at best to a charge of carelessness, and at worst to a charge of dishonesty. When a statement is published unsupported by citations, the reader naturally and necessarily assumes that the statement is original, whether the author expressly says so or not. My reason for touching upon this matter in an editorial report is my conviction that this tendency is reaching the point where editorial censorship is quite as necessary as it is for poor grammar or disorderly illustrations. Another reason is my further conviction that editorial policies tending to restrict citation and bibliographies have, in some measure, been responsible for this tendency to ignore previous literature.

Many inexperienced workers feel that if they can not publish their bibliography, or can publish only restricted portions of it, there is no use in looking up the literature at all. While this, of course, is a superficial and absolutely wrong attitude, we should take great care that editorial policy does not become in any way responsible for intellectual dishonesty.

Another angle of the ethics question is what may be called commercialized science. How and to what extent should commercially interested organizations subsidize investigations of their products by public officers? Shall we, by accepting advertisements, assume moral responsibility for statements by the same firm in another publication, which will be placed upon us as surely as we publish the ads? Under what conditions and from what sources can we safely accept financial assistance in publishing our Journal? These all are calling for sober and careful consideration, with a full comprehension of their import before an answer is given. They all have a direct and more or less constant connection with the editorial office.—PERLEY SPAULDING.

REPORT OF THE ADVISORY BOARD

The Advisory Board made the following report to the Council through its Chairman, M. F. Barrus.

The following report consists of a summary of the activities of the committee of the Society and of activities of organizations upon which the members of the Board serve as representatives of the Society.

Summer Meetings. As the British Association for the Advancement of Science met at Toronto during August, no general summer meeting of the Society was held this year. The Pacific Division of the American Phytopathological Society held their annual meeting at Penticton, B. C., on August 26 to 29 in connection with the seventh annual meeting of the Northwest Association of Horticulturists, Entomologists, and Plant Pathologists. This meeting, as reported by Prof. C. W. Hungerford, was a decided success both as to the number in attendance and to the very interesting sessions that were held. There were other meetings of groups of pathologists, but no report of them has been sent to the Advisory Board and those persons in charge of such meetings are not known by members of the Board. It is regrettable that organized meetings of plant pathologists in this country and Canada should take place without there being a general notice of them and an account of their transactions being reported to the Society. An effort is being made by the Advisory Board to provide for a more extended notice of such meetings in the future.

The Advisory Board has accepted, on behalf of the Society, the invitation of the Pacific Division of the American Phytopathological Society to hold its next summer meeting at Corvallis in conjunction with the annual summer conference of that Division. Prof. C. W. Hungerford will represent the Society on the committee of arrangements.

There is unquestionably a long felt need for another cereal-disease conference. As such a conference would probably be deferred during 1926, it seems advisable to arrange for one in some midwestern state during 1925. The Board is unable at the present time to announce more details. It is expected that these two summer meetings will be held at such times as to make it possible for visitors present at the cereal conference to attend the western meeting also.

The attention of members of the Society will be called in due time to a meeting of the Canadian Division at Quebec some time during the summer. It is not unlikely that some members unable to attend the western meetings will be attracted to the Quebec meeting. Details in regard to this meeting will be published later.

The Advisory Board recommends that the summer meeting for 1926 be held in conjunction with the meeting of the International Congress of Plant Sciences to be held at Ithaca, August 16 to 23 of that year. It has been suggested that not only should invitations to attend the pathological meeting be extended to foreign pathologists at various institutions and experiment stations but that they also be invited through the medium of all phytopathological societies in the world.

Phytopathological Institute. The Chairman, Dr. E. C. Stakman, appointed to this project, reports that no action has been taken by his committee in furtherance of the organization of such an institute, and, inasmuch as its function is now being performed by the recently founded Boyce Thompson Institute for Plant Research, he has requested that the committee on Phytopathological Institute be dismissed.

Tropical Research Foundation. The Tropical Research Foundation is an organization formed under the auspices of the National Research Council and incorporated on June 6, 1924, to promote research for advancing knowledge of plants of the tropics by conducting investigations in plant pathology, entomology, plant breeding, botany, forestry, horticulture, and agronomy, and to publish the results of these. In order to accomplish these results, it may establish and maintain such temporary and permanent stations as may be necessary. The American Phytopathological Society is represented by one member, Dr. L. R. Jones, on its Board of Trustees. It is the duty of the Advisory Board in respect to this Foundation to function as a committee on cooperation. Thus far, the only duty the Board has performed has been to endeavor to aid the Scientific Director in the selection of an assistant pathologist. Doubtless in time the Board will be able to render more valuable assistance and should serve as the medium for presenting to the Society the work of the Foundation which has now only just started.

National Research Council. The Advisory Board Chairman of last year, Dr. C. R. Orton, attended two meetings of the Division of Biology and Agriculture of the National Research Council and made a report of the Board's activities to the Division. The Division voted to continue its support of the Arthur rust project for another year. The Society is now represented on the Division only by the Chairman of the Advisory Board who holds his appointment on the Division until July 1 of the year following his retirement as Chairman of the Board.

Promotion of International Relations in Phytopathology. No definite project was undertaken by the Board in this respect. Efforts were made, as in the past, by pathologists at institutions visited during the summer by foreign scientists to entertain them and to assist them in every possible way. Among such visitors were Dr. Wilfrid Robinson, of the University of Manchester, England; Dr. V. H. Blackman, of the Imperial College, London, and Dr. Arata Ideta, Principal of the Agricultural School, Yamaguchiken, Japan, who made extended trips through the country visiting colleges and experiment stations. There were many other foreign scientists interested in pathology who were brought into close touch with American pathologists through such visits. The Society was represented through its president, Dr. F. D. Fromme, at an international meeting, the first Pan-Pacific Food Conservation Conference, held in Hawaii during the first half of August.

Popular Articles on Plant Pathology. The Advisory Board has given consideration to the development of some agency for the preparation and publication of popular articles about plant diseases and the science of plant pathology. There are numerous popular articles appearing in the daily, weekly, and monthly press on subjects relating to chemistry, astronomy, geology, entomology, and other sciences, but very few on plant pathology. The advantage to our profession of having the public frequently, adequately, accurately, and clearly informed on this subject must be obvious to all plant pathologists.

After approval by the Council, the Board has appointed Dr. W. A. McCubbin to consider the possibility of developing such a service and, if conditions warrant, to initiate it. Dr. McCubbin is empowered to associate with him in this work such assistants as he may require.

Plant Disease Names. A committee on Plant Disease Names was appointed by the Society several years ago and it reported a year later, but while certain principles upon which such names may be based were approved, the names submitted by the committee were not adopted by the Society. No further action has been taken by that committee.

Inasmuch as the Plant Disease Survey of the U. S. Department of Agriculture, in the preparation and publication of reports on plant diseases, must apply common names to plant diseases and, in the application of such names, is guided by the principles adopted by the Society, and inasmuch as the Society is well represented in the Office of Plant Disease Survey through collaboration of members, the Advisory Board has recommended to the Council that this Office be recognized as the agency of the Society in the perfection of principles for naming plant diseases and in securing the more general adoption of names based on such principles.

Special Research and Investigational Projects. The Arthur rust project which was started September 1, 1922, has been actively carried on during the past eighteen months and at the present time seven out of the proposed eleven chapters have been written in preliminary form. Two of these chapters have been revised and practically put into final form. The remaining four unwritten chapters are expected to be completed by July 1. The book will shortly thereafter be ready for publication or as soon as the illustrations can be secured. The financial support of this project is satisfactory up to July 1, 1925, and it is thought that this will see the work nearly completed. Dr. F. D. Fromme spent the month of January on this work and Dr. C. R. Orton spent the month of June on it.

Very little has been done on the seed-borne parasites project beyond verifying references and getting the list of seed-borne parasites ready for publication. The American Seed Trade Association has been interested in having an investigation made of the problems of control of seed-borne diseases, and plans for such an investigation to be conducted through the Crop Protection Institute were prepared by the committee. The Association, however, decided to postpone making the necessary expenditure until a later date. Drs. C. R. Orton, M. T. Munn, and M. F. Barrus are members of this committee.

The Committee on Standardized Media for Fungous Cultures consists of Drs. G. H. Coons and L. M. Massey. Some work has been started by the committee and it wishes to report progress.

Investigations on Plant Diseases and on Fungicides Conducted Through the Crop Protection Institute. The cereal seed treatment project is cooperative between the American Phytopathological Society and the Crop Protection Institute. Drs. E. C. Stakman and C. R. Orton are members of the committee in charge. The principal object of the work this year was to determine the comparative effectiveness of certain dust and liquid fungicides in the control of covered smuts of wheat, oats, and barley. Investigations were carried on cooperatively with stations in Idaho, Washington, Ohio, Pennsylvania, New Jersey, Minnesota (4 stations), Quebec, Ontario, and Manitoba. The results this year indicate copper carbonate dust to be the most satisfactory fungicide for the control of bunt in wheat and formaldehyde for the control of oat smut. The results of the treatment for the control of barley smuts were inconclusive, owing to the small number of trials and to a low percentage of smut in the checks. A complete report of the work will be submitted to the Crop Protection Institute.

Scalecide investigations are being actively continued along the same lines as last year. Extensive measurements on trunk, twig, and leaf growth and on yield have shown no

differences from check trees at the present time. There is no positive evidence yet as to the effect of Scalecide on fire blight control. Dr. C. R. Orton has served as chairman of the committee for the Crop Protection Institute.

The crown gall investigations project was definitely organized on May 10, 1924, with an advisory committee consisting of Drs. I. E. Melhus, as Chairman, G. W. Keitt, and M. F. Barrus. The men chosen as investigators are Dr. A. J. Riker and Mr. L. W. Boyle, of Madison, and Mr. J. H. Muncie, of Ames. Part of the work is being conducted in Wisconsin and part in Iowa. The project as laid out at present will run for two years for the maintenance of which the sum of $12,000 has been secured from the American Association of Nurserymen, individual nurserymen, the Iowa Agricultural Experiment Station, and the Wisconsin Agricultural Experiment Station.

Sulfur investigations are being concluded so far as the present project is concerned. The services of the two investigators expired during September, and reports of their work have been submitted to the project committee consisting of Drs. G. H. Coons, C. R. Orton, and P. J. Parrott.

The Furfural Investigations Committee consists of Drs. C. R. Orton, E. C. Stakman, and I. E. Melhus. Extensive tests of this material, which is one of the aldehydes, has been made at the Iowa Experiment Station. It has apparently fungicidal properties similar to formaldehyde in the treatment of Rhizoctonia on potatoes, but dissimilar to it in its effect on cereal seeds. The investigation at this stage has indicated that the material has fungicidal properties which will be studied further.

"Certain aspects of some copper salts" is the name of the most recent project to be accepted by the Crop Protection Institute. The signatures of three companies have been secured to an agreement, namely, Nichols Copper Company, the Balbach Metals Corporation, and the Goldsmith Bros. Smelting and Refining Company. The sum assumed by them totals $3,000 a year for a period of two years. The cooperation of the Boyce Thompson Institute has been obtained in providing space and facilities for the copper studies, placing t..em under the supervision of Dr. Kunkel and Dr. Kraybill. Dr. William Crocker has accepted chairmanship of the committee and one other member, Dr. N. J. Giddings, has been appointed.

At the final meeting of the 1924 Advisory Board on January 1, 1925, Dr. M. F. Barrus was elected chairman for the ensuing year.

REPORTS OF OTHER COMMITTEES

Auditing Committee. The Auditing Committee, George L. Peltier and Charles Chupp, reported as follows:

We, the undersigned, have examined the books of the American Phytopathological Society (receipts and expenditures) and have not only found them correct, but prepared in the most excellent manner. We thank Dr. R. J. Haskell and Miss Mary G. Van Meter for their care in conducting this business.

We, the undersigned, have examined the books of PHYTOPATHOLOGY (receipts and expenditures) and have found them to be correct in every detail due to the excellent services of Dr. R. J. Haskell and Miss Mary G. Van Meter. We would suggest that the annual dues be paid in such a form that their face value will not be less than four dollars in American money.

Committee on Codifycation of Rules. The chairman of the committee, Dr. G. R. Lyman, submitted a set of standing rules of the Society together with proposed amendments to the constitution. On account of their length, the rules were adopted without being read and it was moved that they be published in PHYTOPATHOLOGY. These rules together with the proposed amendments to the constitution will appear in connection with the list of members of the Society in some one of the 1925 numbers of PHYTOPATHOLOGY.

Crown Gall Committee. I. E. Melhus presented the report for the crown gall committee as follows:

The crown gall work is under the immediate direction of a committee appointed by the Crop Protection Institute, consisting of: Dr. I. E. Melhus, Iowa State College, Ames, Iowa; Dr. Geo. Keitt, University of Wisconsin, Madison, Wisconsin, and Dr. M. F. Barrus, Cornell University, Ithaca, New York. The sources of funds are the National Nurserymen's Association, Iowa State College, and University of Wisconsin.

This committee met in Chicago last May with Professor W. C. O'Kane, Chairman of the Crop Protection Institute, and outlined the attack of the problem, budgeted its money allotment, and selected three research men, Mr. J. H. Muncie, stationed at Ames, Iowa, under the direction of Dr. I. E. Melhus; and Dr. A. J. Riker and Mr. L. W. Boyle located at Madison, Wisconsin, under the direction of Dr. Geo. Keitt.

The Crown Gall Committee is persuing its studies along four major lines as follows: (1) the effect of crown gall and hairy root on young trees, (2) the life history of the bacterium causing the disease, (3) the differential diagnosis of crown gall symptoms, and (4) the control of the disease in the nursery and orchard. It is recommended that the Crown Gall Committee be continued.

Committee on Plans for International Congress of Plant Sciences. The organization committee on the international congress of plant sciences has now practically completed the essential machinery of the permanent organization. This will consist of an executive committee composed of B. M. Duggar, H. C. Cowles, and H. H. Whetzel who, together with an executive secretary for each section, will constitute the general organization committee. Practically all of the societies interested in the international congress have designated one of their members to act as executive secretary. The duty of each executive secretary is to work up the program for papers to be presented at the scientific sessions which will consist of three half-day sessions. The congress is to be held at Cornell University, Ithaca, New York, the third week of August, 1926. I understand that the American Phytopathological Society has designated Dr. Ronald Reddick as their executive secretary and I am writing him in regard to his duties in this connection.—H. H. WHETZEL.

Joint Committee on Nomenclature. The Committee recommends the adoption and uniform use of the following terms in their Latin forms as here defined for species and subordinate groups of fungi, *viz.*, species, varietas, and forma.

Species. This term should be applied to a group of individuals which can be segregated on the basis of morphological characters of such a nature as to be applicable and determinable by mycologists and pathologists in general and will be available for general, practical taxonomic purposes.

Varietas. This term should be applied to a group of individuals of next lower rank than a species and should be designated by a trinomial. A varietas should also be distinguished by morphological characters, but such as are less constant and less important than those used for specific segregation.

Forma. This term should be applied to a subdivision of a species or variety which is characterized and distinguished primarily by physiological instead of morphological characters, although in some cases there may be very minor morphological characters distinguishable by intensive study. The segregation should be made, however, primarily on the basis of physiological behavior. Formae are to be designated by Arabic numerals, for example: *Glomerella lindemuthiana* F. 1; *Puccinia graminis tritici* F. 1.

It is recommended that hereafter the term forma be applied only to physiological groups, as indicated, and not to morphological groups or segregations.

It is recommended that the term "physiologic" or "physiological" or its abbreviation "P" be prefixed to avoid any confusion with morphological forms which will

probably continue to be recognized to some extent. The complete and approved designation then would be, for example, *Puccinia graminis tritici P. F. 1.*

The above report signed by C. R. Ball for the American Society of Agronomy, H. S. Jackson for the Mycological Section of the Botanical Society of America, E. C. Stakman for the American Phytopathological Society, and C. F. Shear for all three societies was adopted and the committee discharged.

Pure Culture Supply Project. The chairman of the Committee of Pure Culture supplies, Dr. C. L. Shear, reported that, through the Division of Agriculture and Biology and the Division of Medical Sciences of the National Research Council, a committee had been organized including representatives of the American Bacteriological Society and the American Phytopathological Society. Through the efforts of this Committee the sum of $24,000.00 has been contributed by the Rockefeller Foundation for the support of this project for the next five years. At the request of the National Research Council, the carrying out of this project will be placed in the hands of a Committee representing the Society of American Bacteriologists, the Society of Medical Pathologists and Bacteriologists, the Zoological Society, the American Phytopathological Society, and the McCormick Memorial Institute of Chicago which is to take charge of the distribution of the cultures. These are expected to include eventually all microbiological organisms which can be supplied in pure culture. A catalog of the cultures which are available will be prepared as soon as practicable, giving prices and other information concerning the work. The most active cooperation of all biologists interested in this project is solicited.

This report was adopted and a resolution of appreciation and thanks to the Research Council approved unanimously. Dr. C. L. Shear was then elected the representative of this Society on the proposed committee to take charge of this project.

Committee on International Phytopathological Publications and Relations. Doctor Shear, Chairman of this Committee, reported that, in accordance with instructions and authority given the Committee by the Society at the Cincinnati meeting, arrangements have been made with Dr. H. M. Quanjer of the Phytopathological Institute, Wageningen, Holland, whereby he will act as the Editor of PHYTOPATHOLOGY for Europe, solicit subscriptions, and receive and transmit papers offered for publication in the Journal. Such papers are to be accepted in English, French, or German language, the total number of pages of such papers from Central European authors not to exceed 100 during the year. Special subscription rates have been offered in those European countries whose currency is below par. The rate according to this plan for the calendar year 1925 has been adjusted on the basis of European exchange. According to this the prices in the different countries will be as follows:

Albania	$2.50	Latvia	$2.50
Austria	2.50	Lithuania	2.50
Belgium	2.50	Netherlands	5.35
Bulgaria	2.50	Norway	2.92
Czechoslovakia	2.50	Poland	5.47
Denmark	3.61	Portugal	2.50
Esthonia	2.50	Rumania	2.50
Finland	2.50	Russia	2.50
France	2.50	Serbs, Croats, Slovenes	2.50
Germany	2.50	Spain	3.82
Great Britain	5.00	Sweden	5.46
Greece	2.50	Switzerland	5.47
Holland (Netherlands)	5.35	Turkey	2.50
Hungary	2.50	Ukraine	2.50
Italy	2.50	Yugoslavia	2.50

The Committee suggested a substitute title for the Journal beginning January 1, 1925, as follows:

"Phytopathology, an International Journal
and Official Organ of the American
Phytopathological Society"

This report was received and adopted and the Committee discharged.

Resolutions Committee. The American Phytopathological Society wishes to express its appreciation to the local committee who made arrangements for the convenience of the Society during this meeting. They especially appreciate the courtesy of Dr. William A. Taylor and the members of the staff of the Bureau of Plant Industry in offering facilities for visiting and inspecting the offices and laboratories, as well as the experimental station at Arlington.

The reports of the editor and the secretary-treasurer showing the excellent condition in which the Society now finds itself are especially gratifying and the Society takes this opportunity to express its sincere appreciation of the unselfish and efficient services of its officers.

The above resolutions were adopted. (See also resolutions at end of this report.)

ACTION OF THE COUNCIL

In addition to the appointments already mentioned in this report under the heading "Officers and Representatives," the Council reported the following actions which were approved by the Society.

It is recommended that there be established a standing committee on necrology to consist of three members whose terms of office shall be three years, such committee to be appointed by the Council.

It is recommended that the program committee arrange for a half-day session at the Kansas City meeting next year on the subject of the teaching of plant pathology.

Donald Reddick was appointed to serve as Executive Secretary for the Phytopathological Section of the International Botanical Congress of 1926.

E. C. Stakman and F. J. Schneiderhan were appointed to take charge of the preparation of a report of the Washington meeting.

MISCELLANEOUS BUSINESS

The secretary's report of last annual meeting as printed in the April, 1924, number of PHYTOPATHOLOGY was adopted.

It was voted to hold the next annual meeting of the Society at Kansas City in conjunction with the American Association.

In view of the fact that but $21.00 out of the original $105.00 remains for sending gratis copies of PHYTOPATHOLOGY to European pathologists and institutions, and because of the reduced rates that are now being offered them, the Society voted to cut down the present list and spend only $21.00 for these free copies during 1925.

Announcement was made of the first award of the Eunice Rockwood Oberly Memorial Prize. The prize was awarded to Mr. Max Meisel, formerly of the Science Division of the New York Public Library, for the first volume of his extensive bibliography on American natural history, published in the fall of 1924 by the Premier Publishing Company, 626 Broadway, Brooklyn, New York.

The Council was given power to act for the Society concerning any contribution that should be made to assist in financing BOTANICAL ABSTRACTS during 1925.

R. J. HASKELL, *Secretary*

IN MEMORIAM

During the last year death has claimed two of our members, A. D. Selby, of Ohio, and G. F. Puttick, of the Union of South Africa.

AUGUSTINE DAWSON SELBY, for nearly thirty years botanist at the Ohio Agricultural Experiment Station, died May 7, 1924, at the age of 64. He received his undergraduate training at the Ohio State University and studied also at Rutgers College, Washington University, and Columbia University. His experimental activities and his published work dealt largely with practical problems in plant disease control. He also gave considerable attention to Ohio weeds and to the breeding of improved varieties of several crops. He was a charter member of the American Phytopathological Society and always displayed a very great interest in the Society and its welfare, regularly attending all of its meetings so long as his health permitted.

GAIL FERGUSON PUTTICK, after completing his undergraduate studies in South Africa, entered Cornell University where he specialized in Plant Pathology and received his B.S. Degree. He then studied for two years at the University of Minnesota, receiving the M.S. Degree. In 1921 he was appointed Plant Pathologist of the Experiment Station at Potchefstroom, Union of South Africa. He retained this position until his death on April 23, 1924, at the age of 29 years.

It is with deep regret that the Society places on record the decease of these loyal and esteemed colleagues.